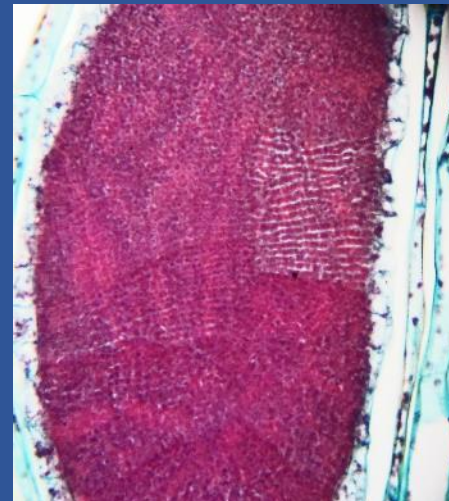
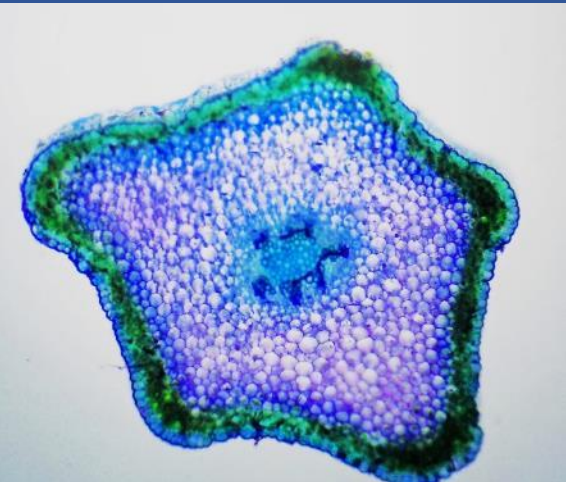
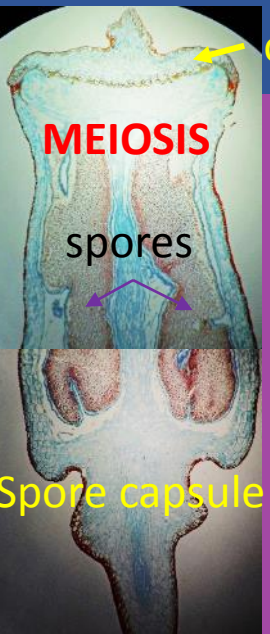


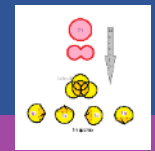
**Bryophytes(nonvascular) &
Pteridophytes(vascular):
Silurian to Recent 'primitive'
land plants**



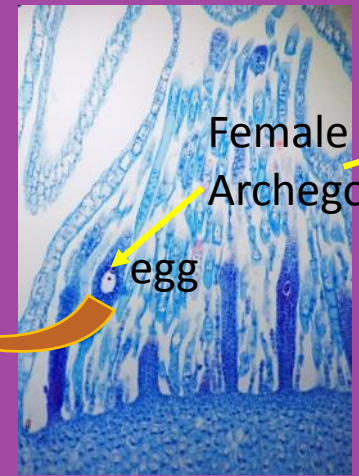
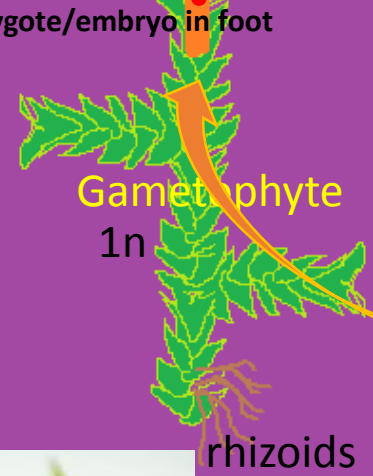
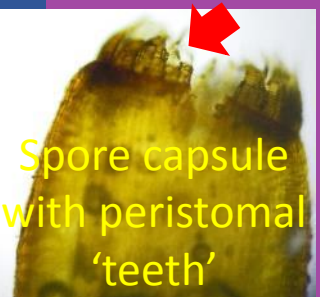
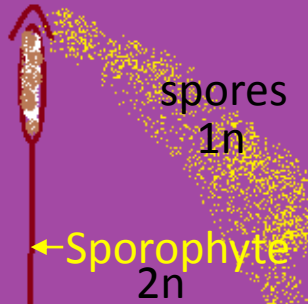
Bryophytes: Musci: the Mosses – gametophyte dominates life cycle



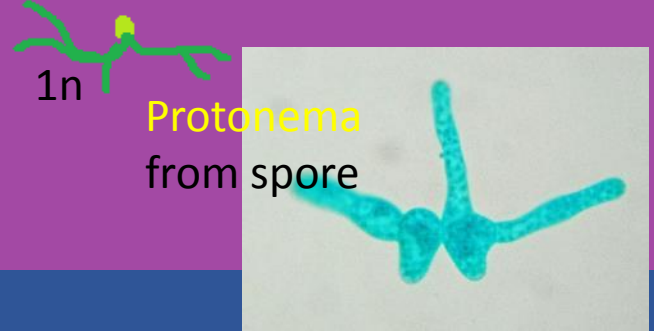
operculum



Spore capsule



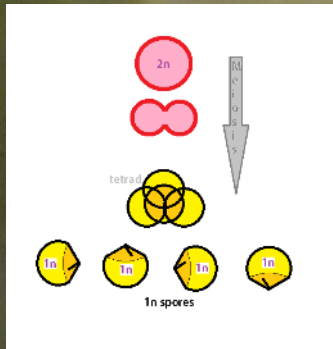
Alternation of generations



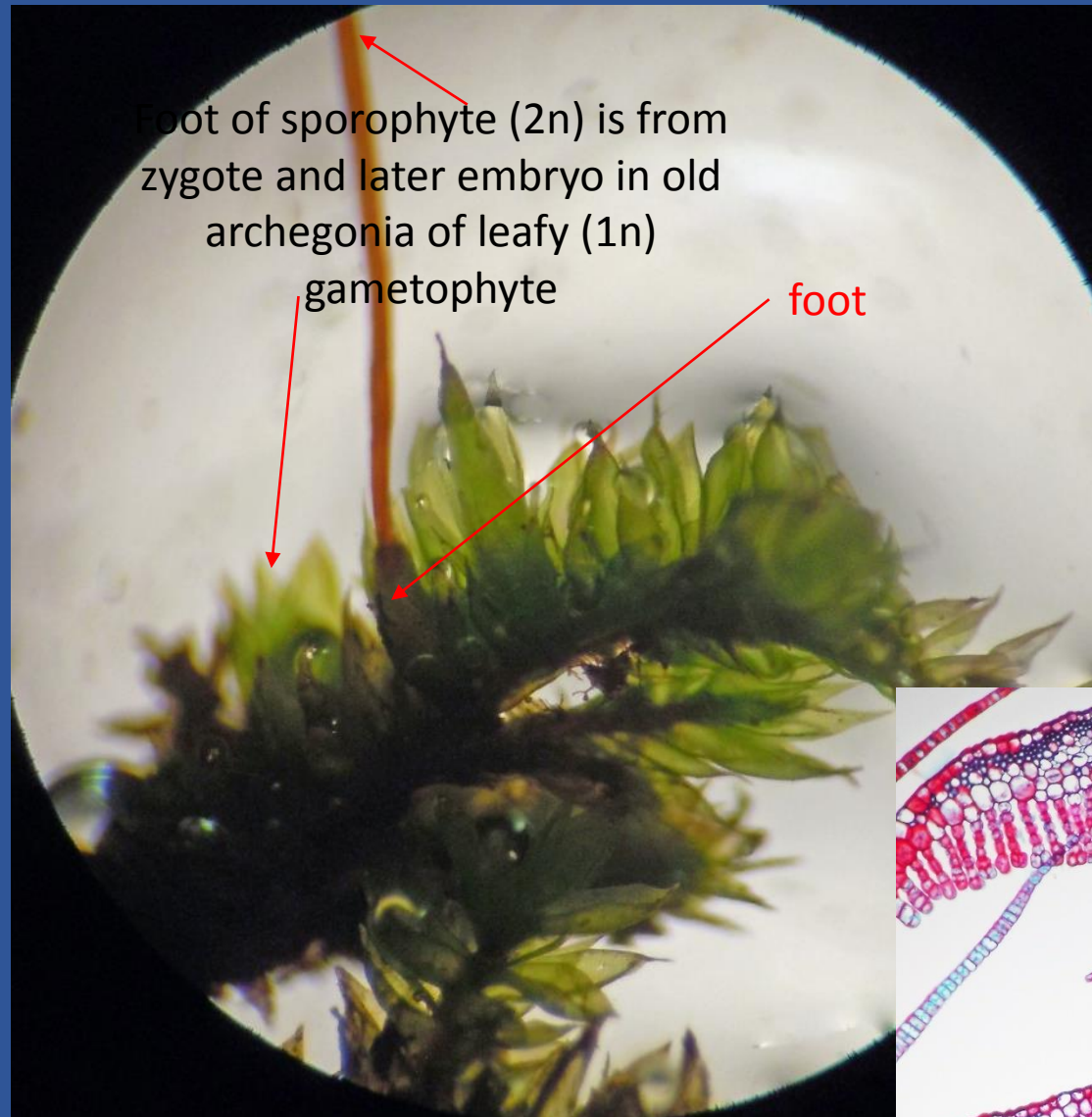
Alternation of generations



Spore capsule
with peristomal
'teeth' (16)



Foot of sporophyte (2n) is from
zygote and later embryo in old
archegonia of leafy (1n)
gametophyte



foot



cs Leaves

Moss leaf
surface



Cell wall

Chloroplasts

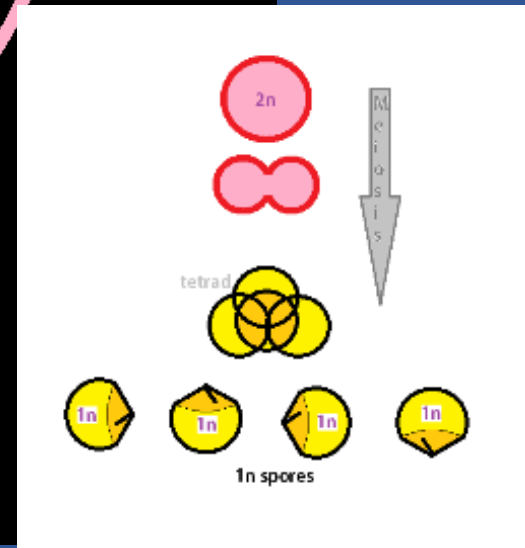
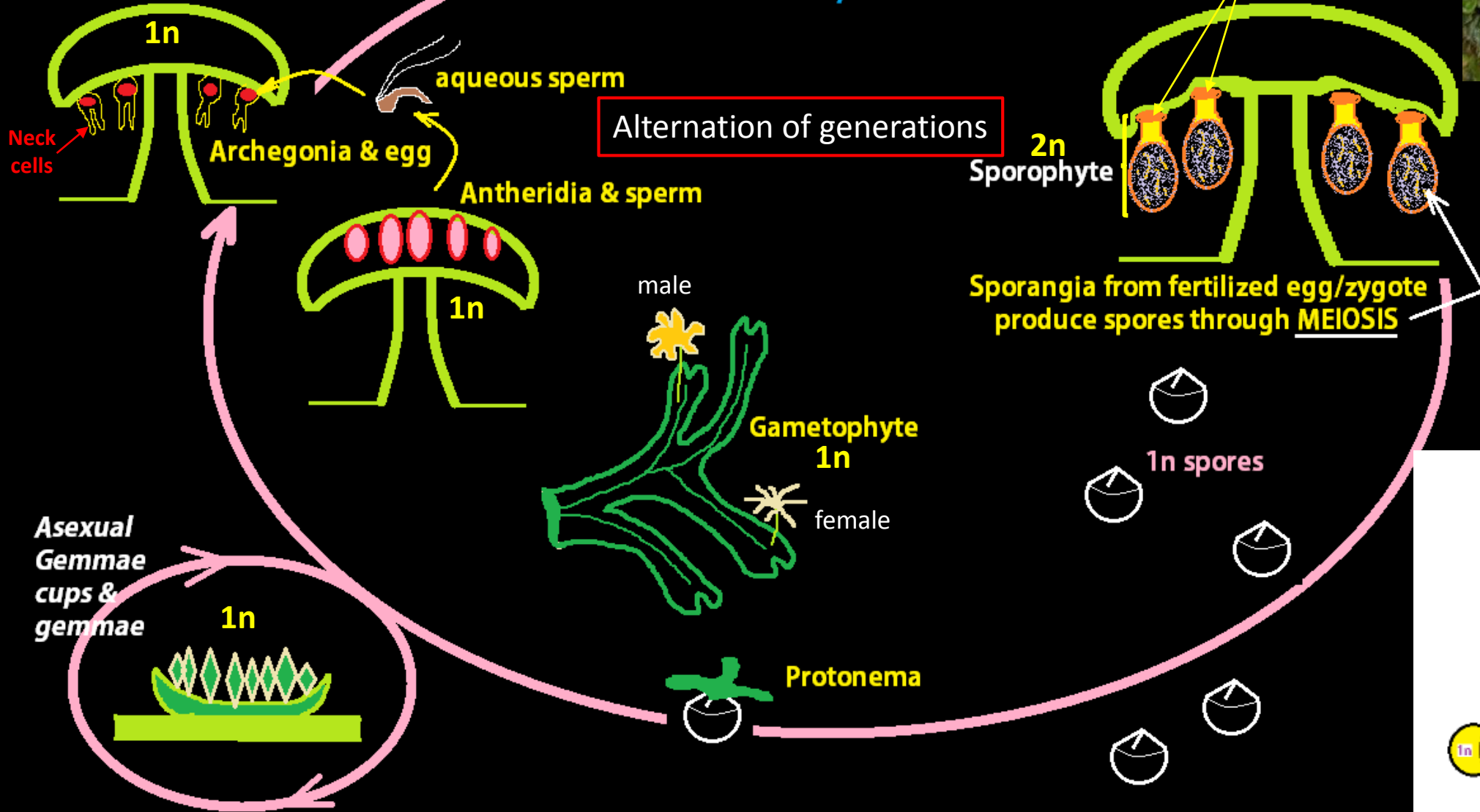
each cell is 50 um X 10 um

Gametophyte (1n)
generation dominates

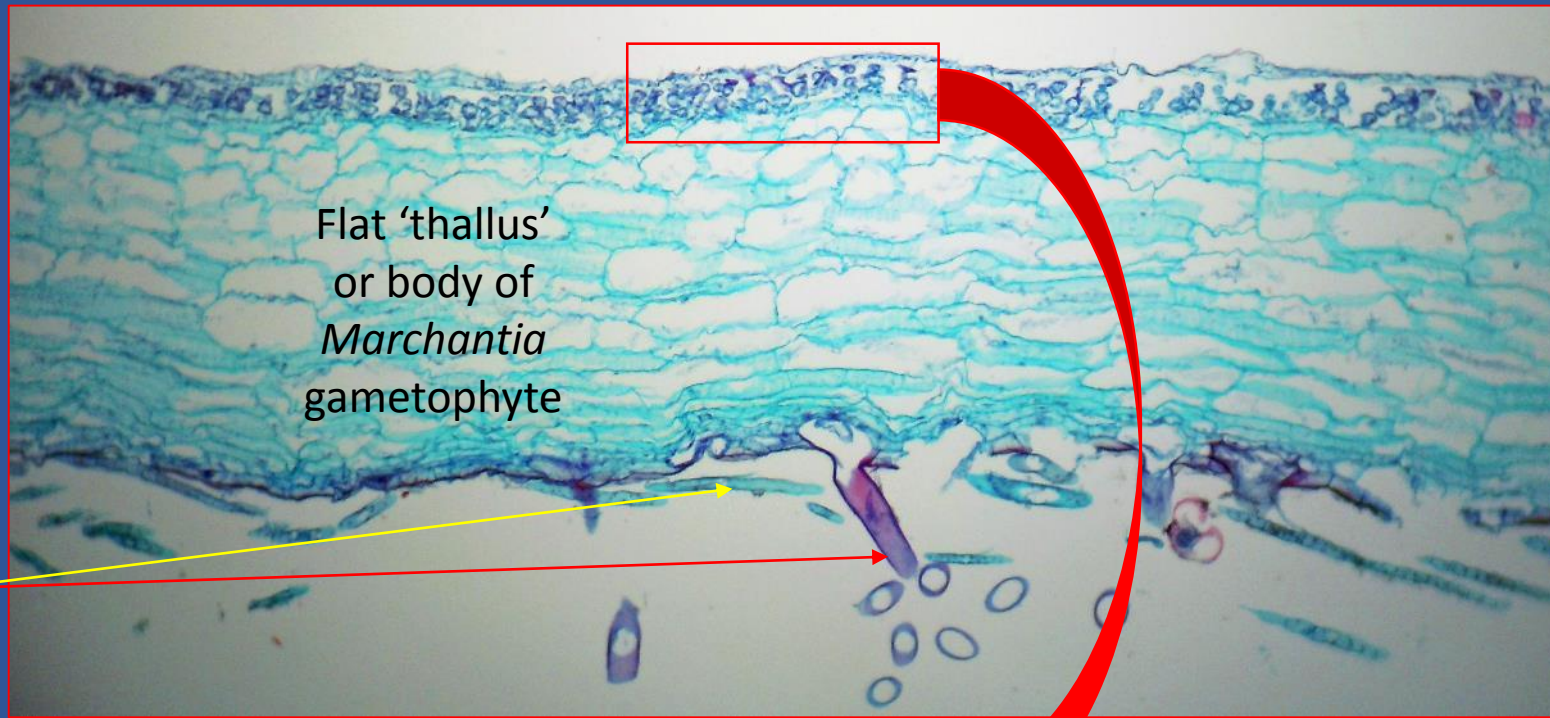
Marchantia sp.: liverworts

Alternation of generations

Foot From
Zygote -2n

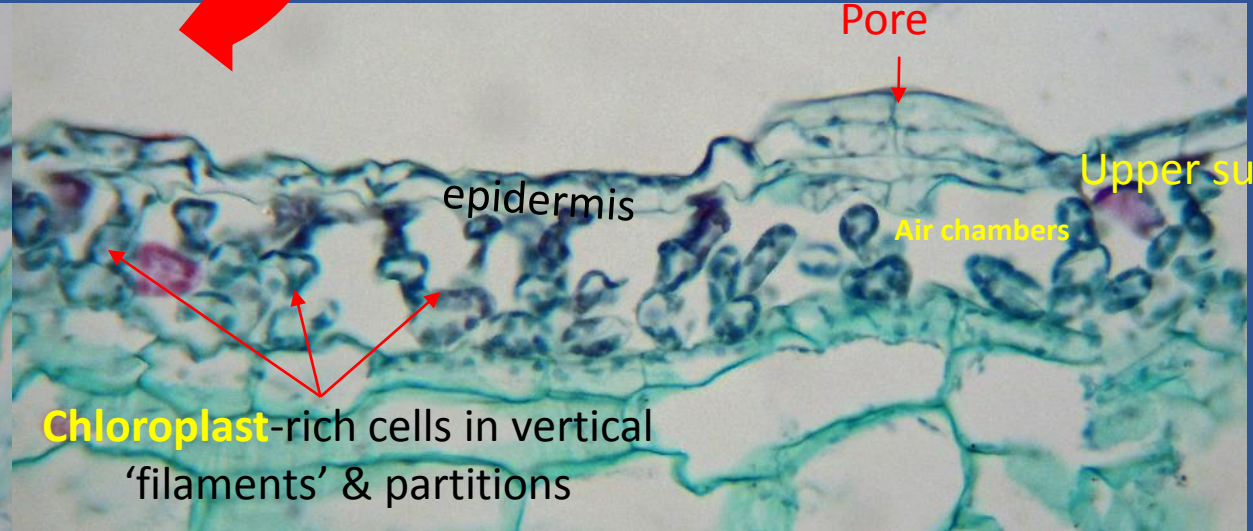


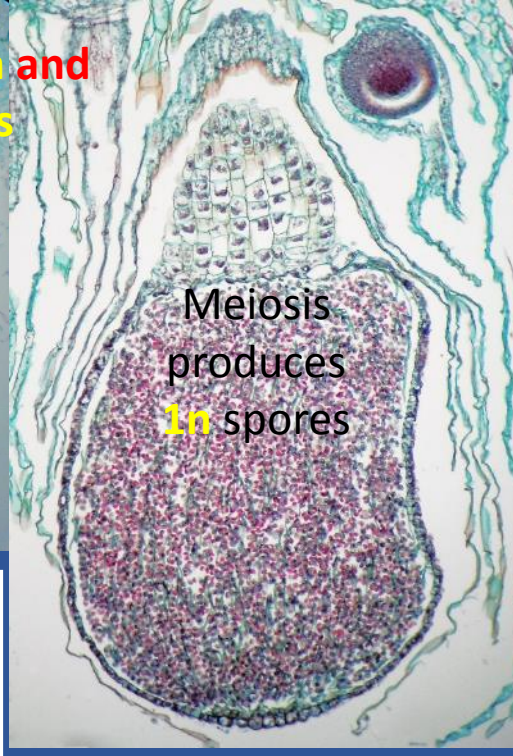
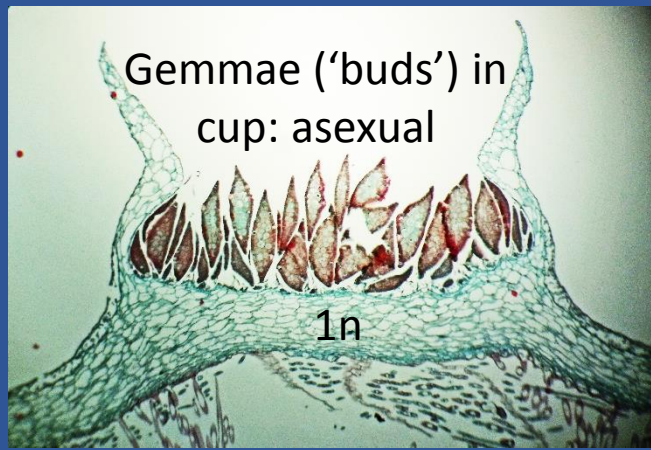
Rhizoids &
scales



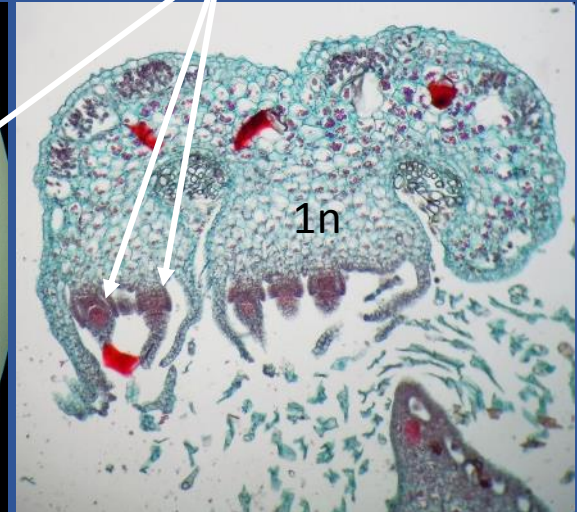
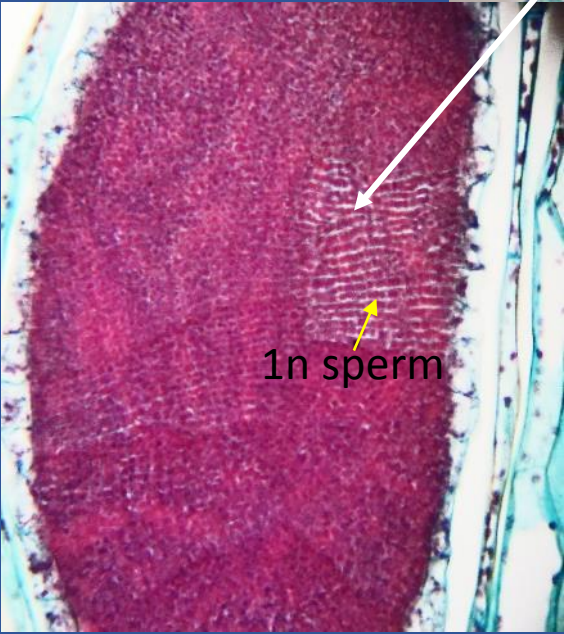
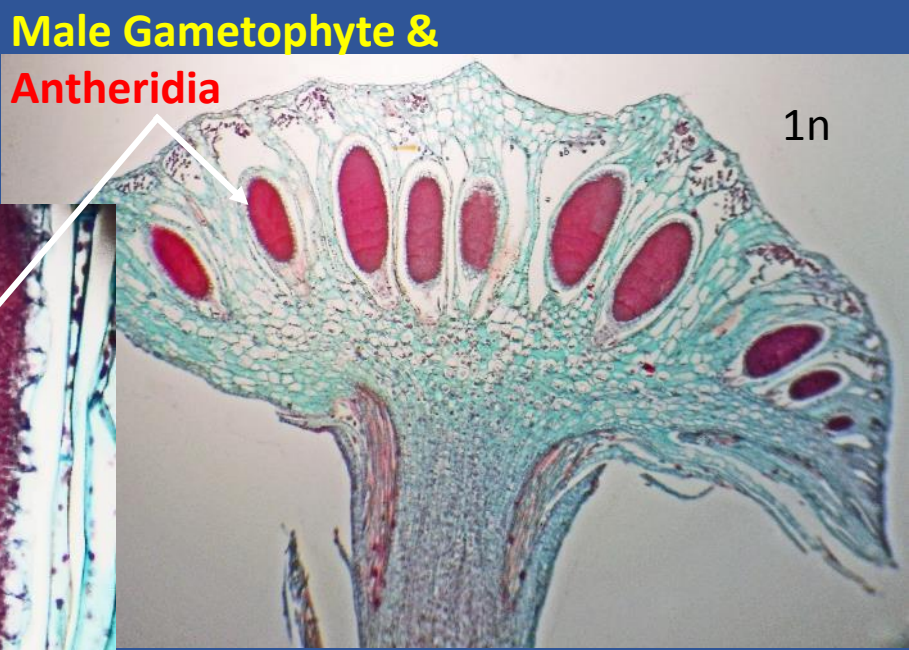
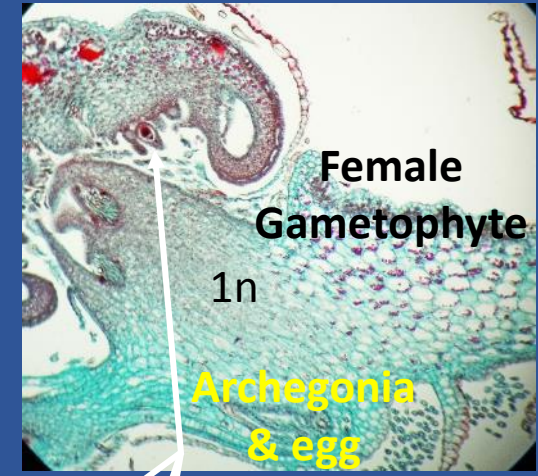
Upper surface

Lower surface

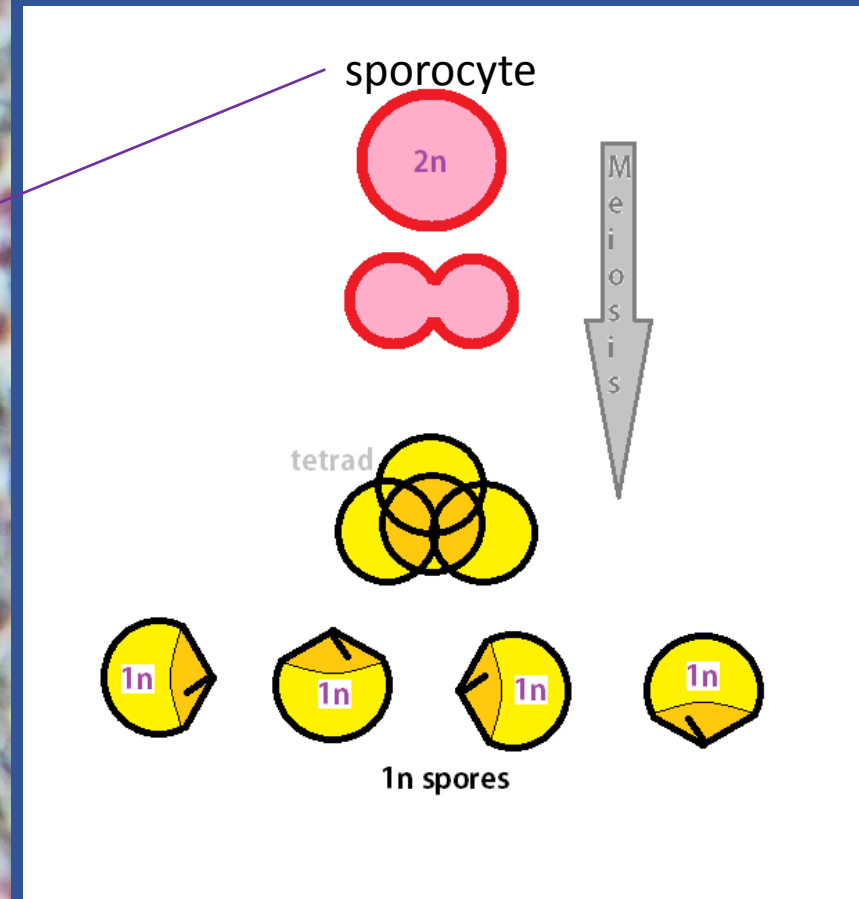
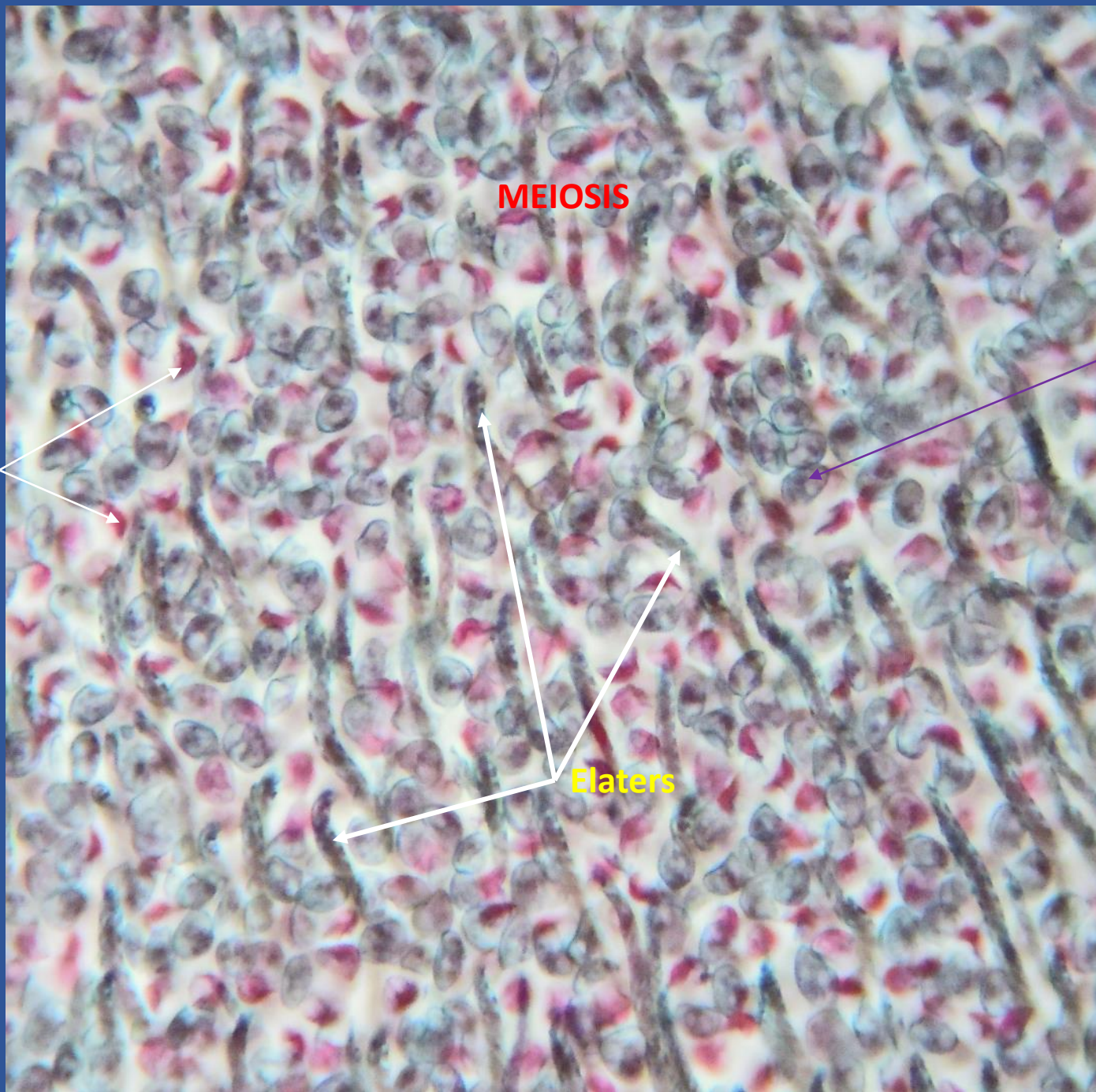


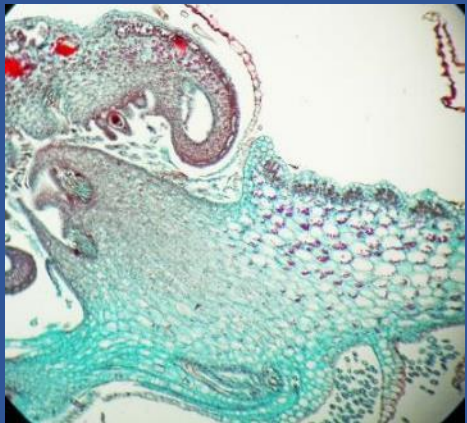


Bryophytes: Hepaticae:
the 'liverworts'
Marchantia



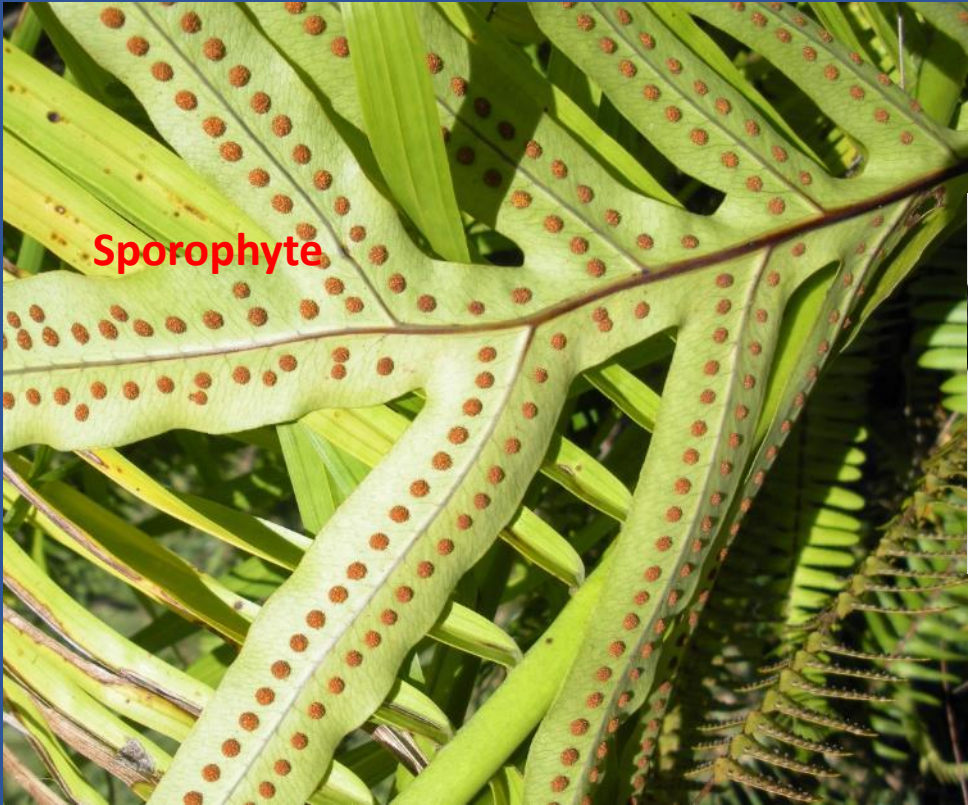
gametophyte dominates life cycle;
Alternation of generations





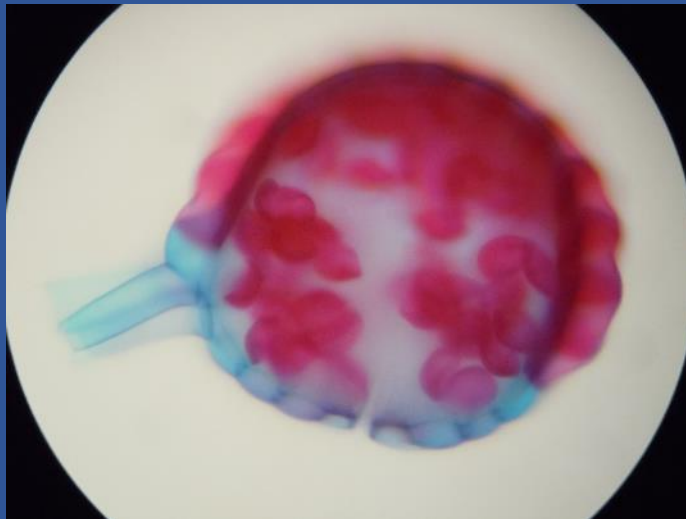
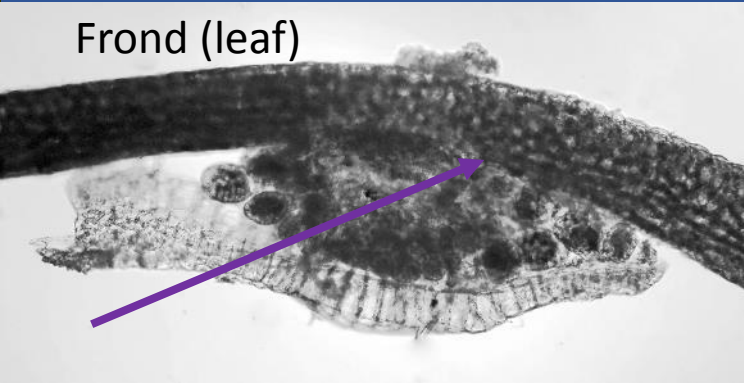
Marchantia on banks of Chipola River;
circles are gemmae cups

Non-seed-forming Vascular plants: Ferns & their Allies - Pteridophytes



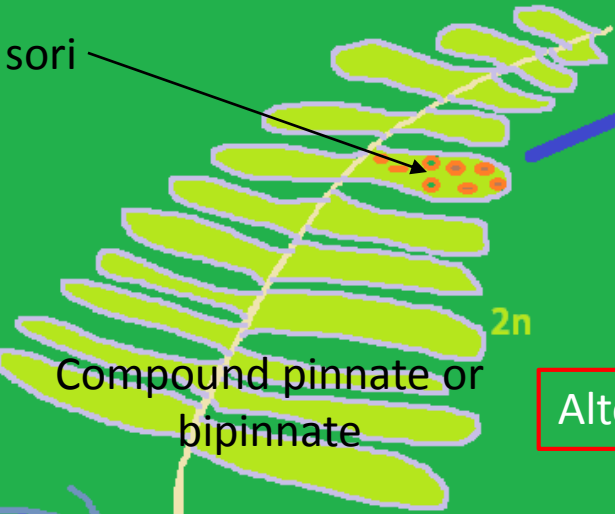
Alternation of generations

Fron





sori



Compound pinnate or bipinnate

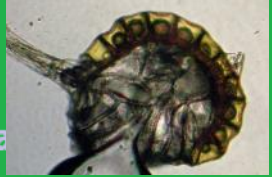
2n

Sporophyte

2n

Alternation of generations

Sporangia

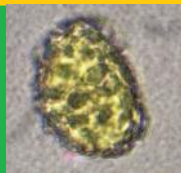
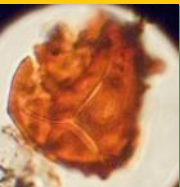


Meiosis

1n

spores

Permian spore 'trilete'



Monolete spore

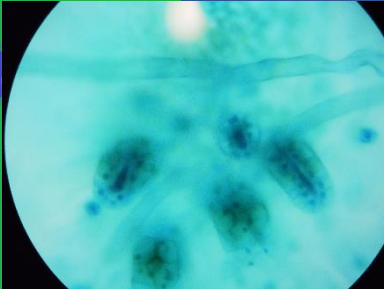


Gametophyte

sperm

1n

Archegonia & egg

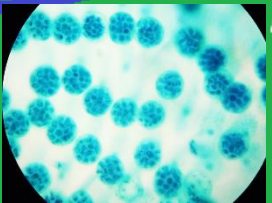


fertilization produces new sporophyte

Zygote & embryo sporophyte

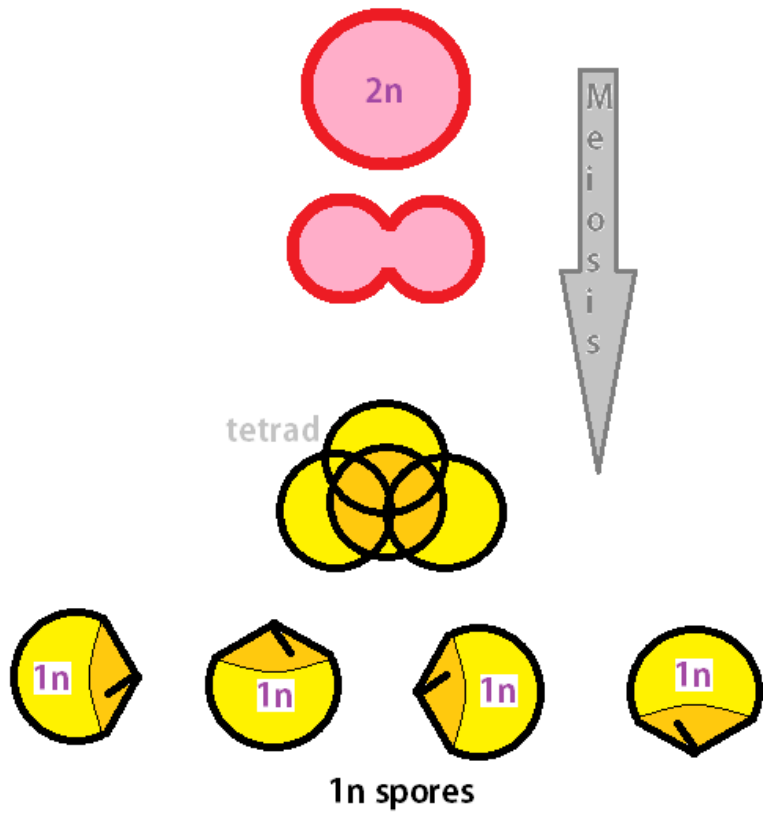
Sporophyte dominates life cycle

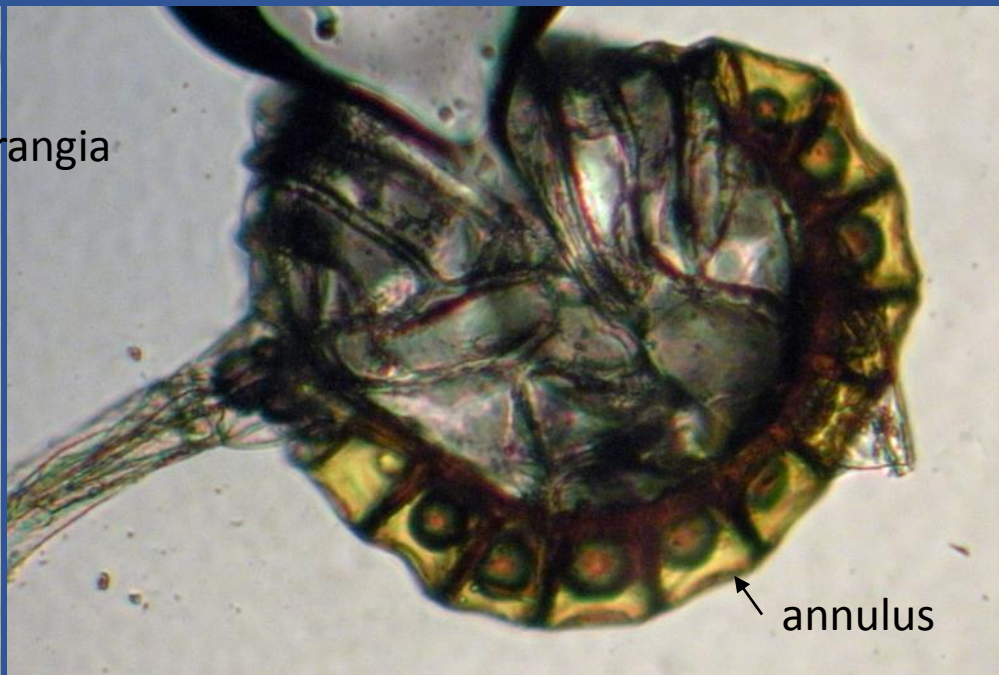
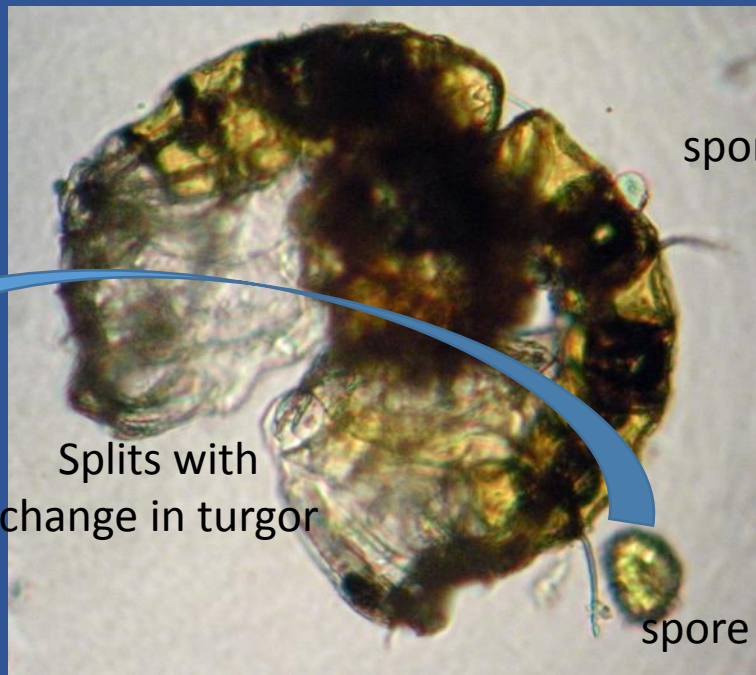
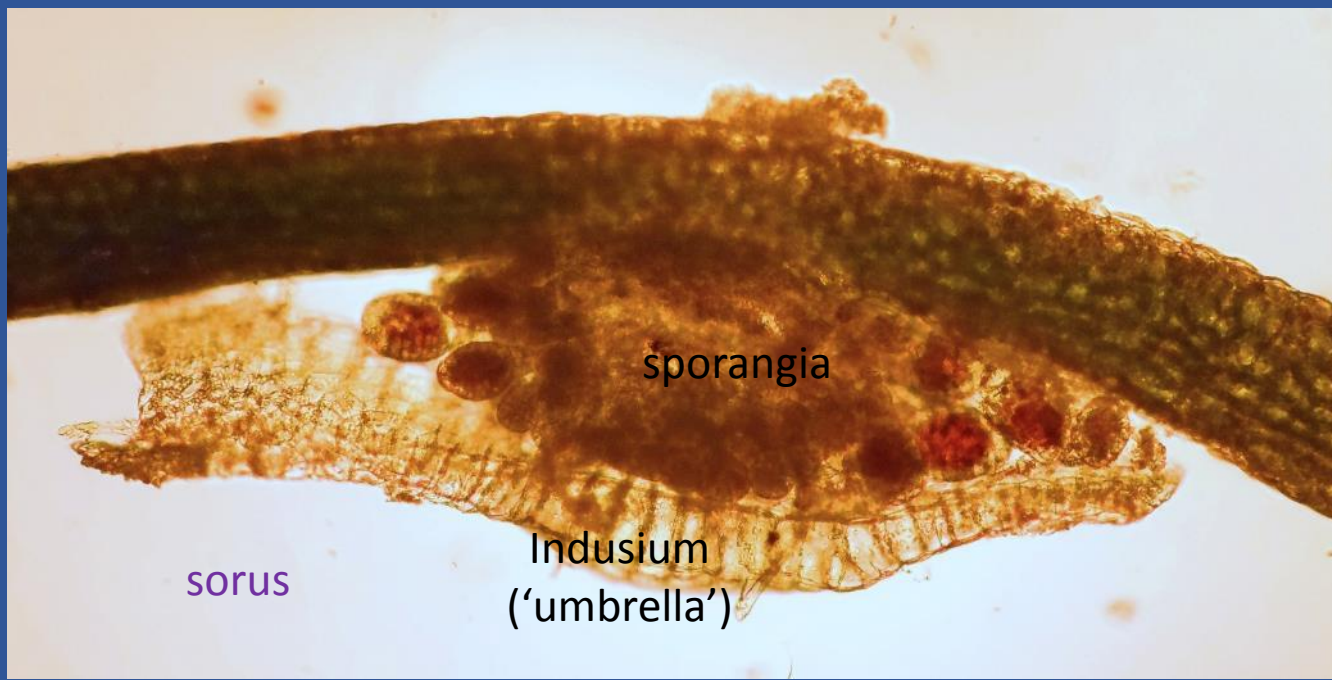
Antheridia & sperm

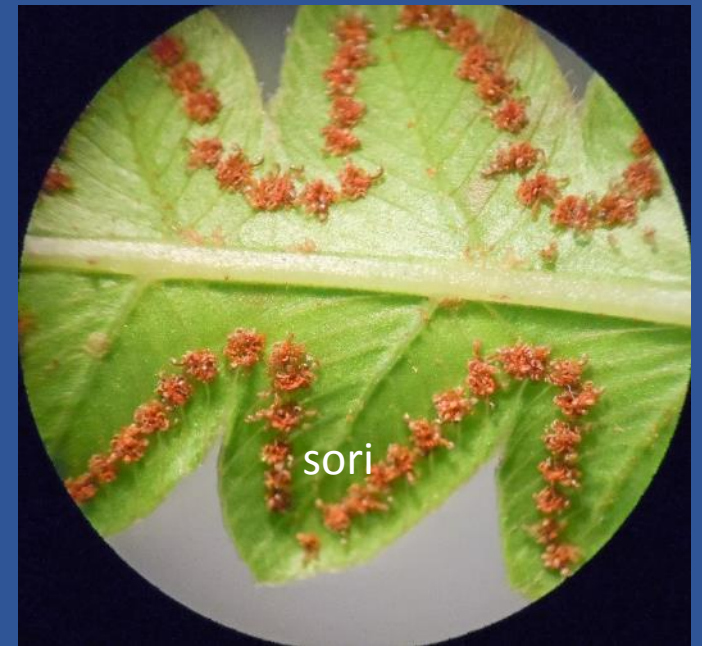
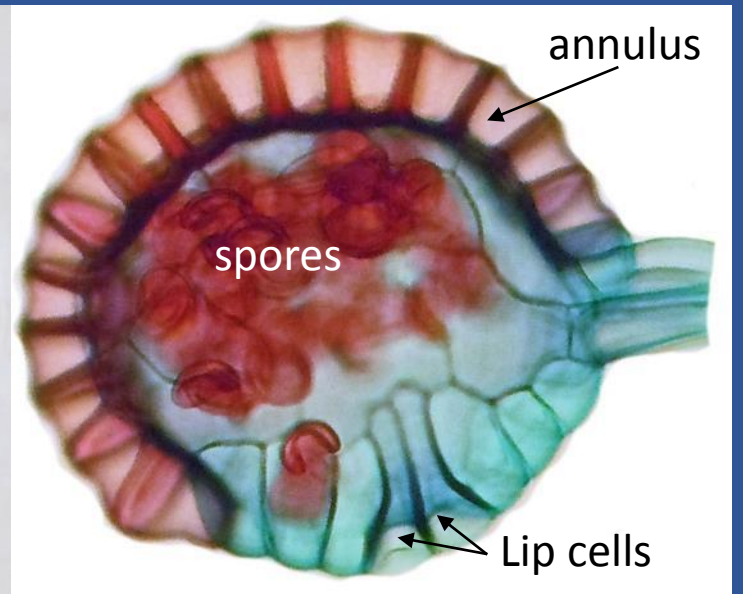
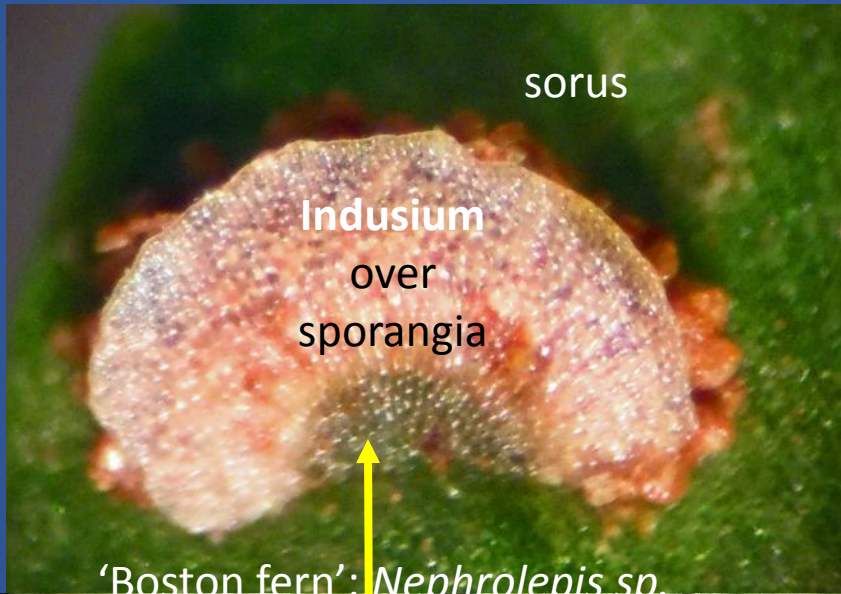


4mm Gametophyte



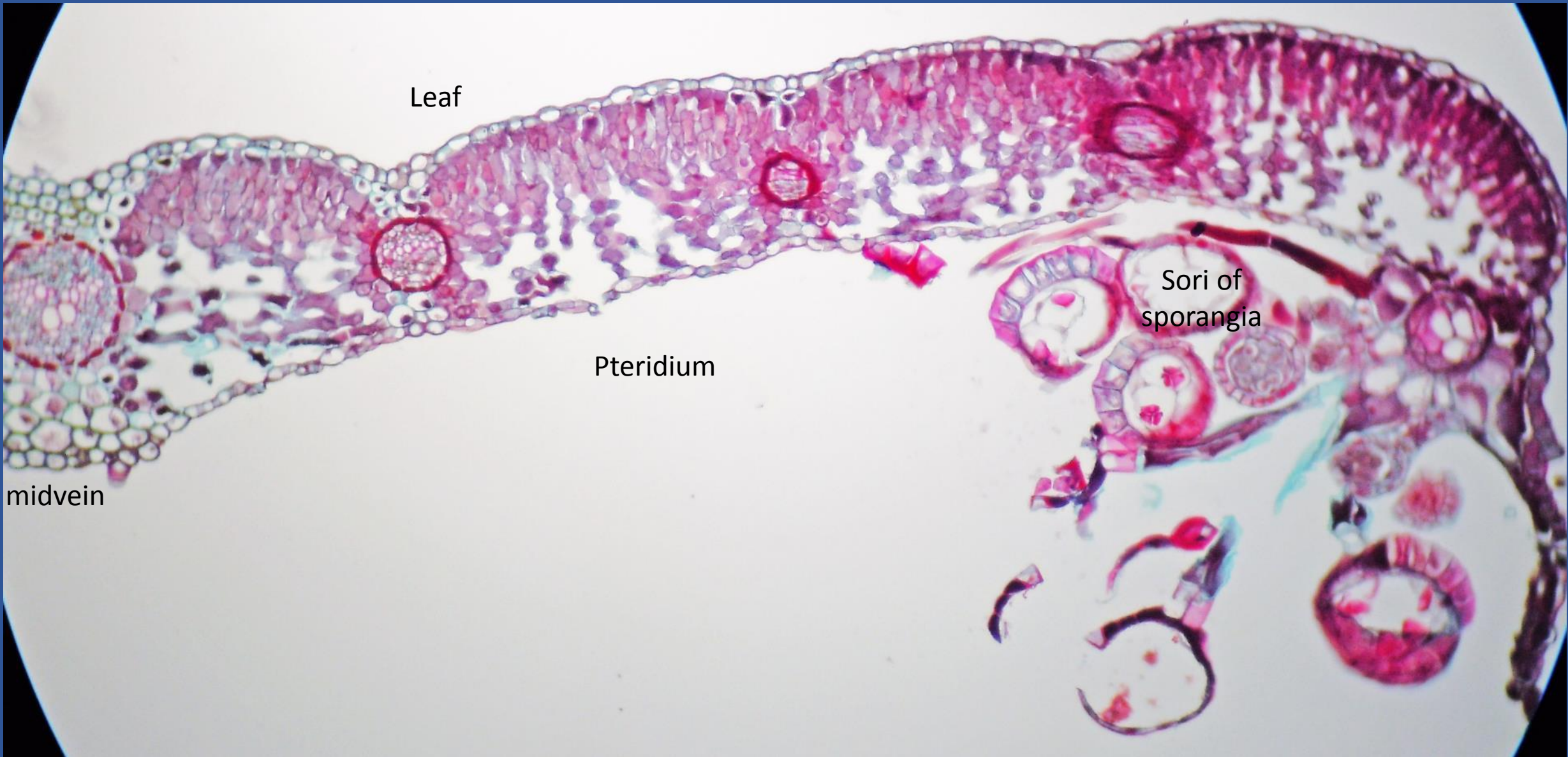












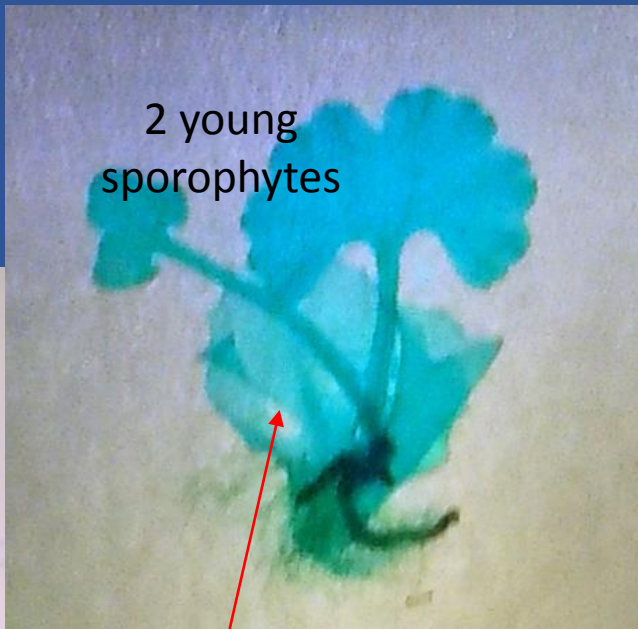
Leaf

Pteridium

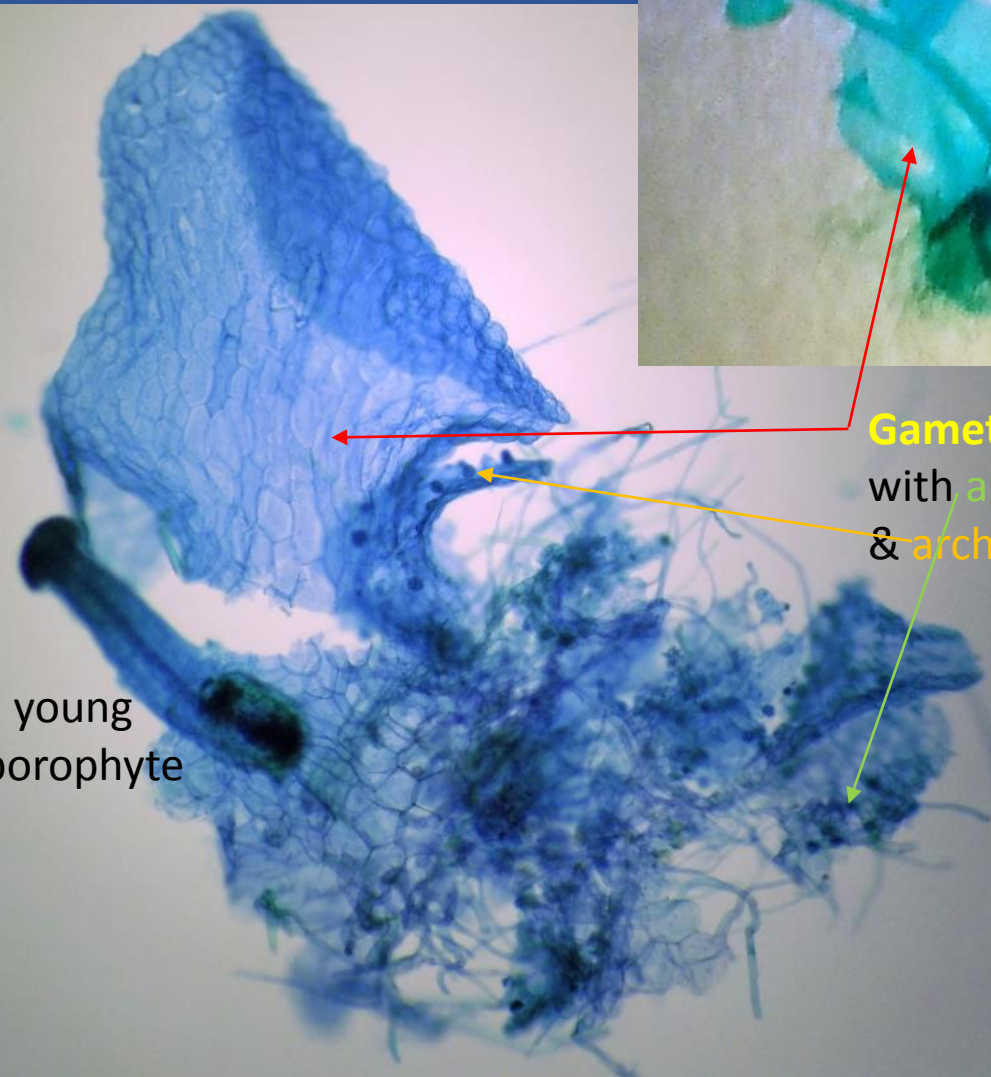
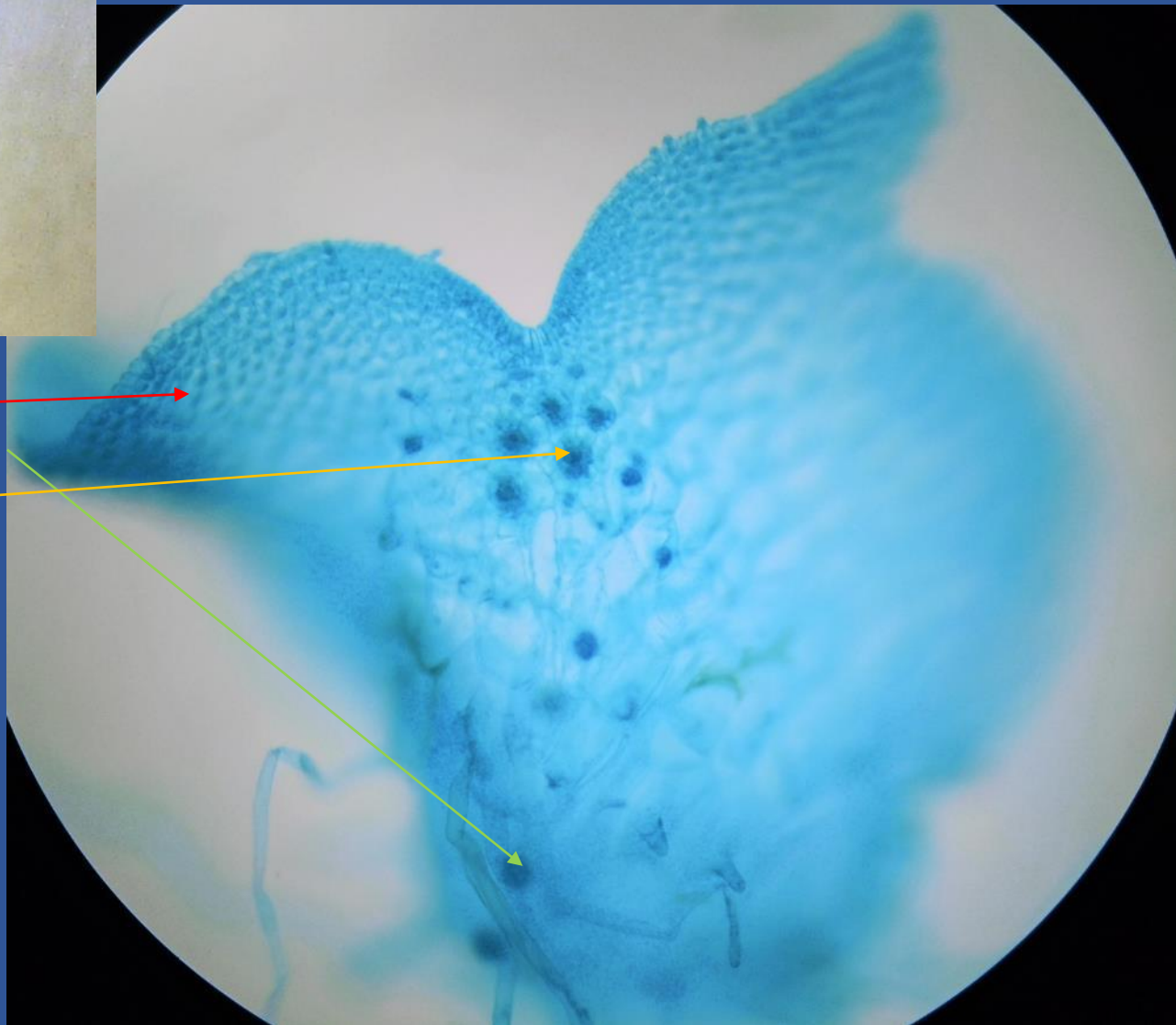
Sori of
sporangia

midvein

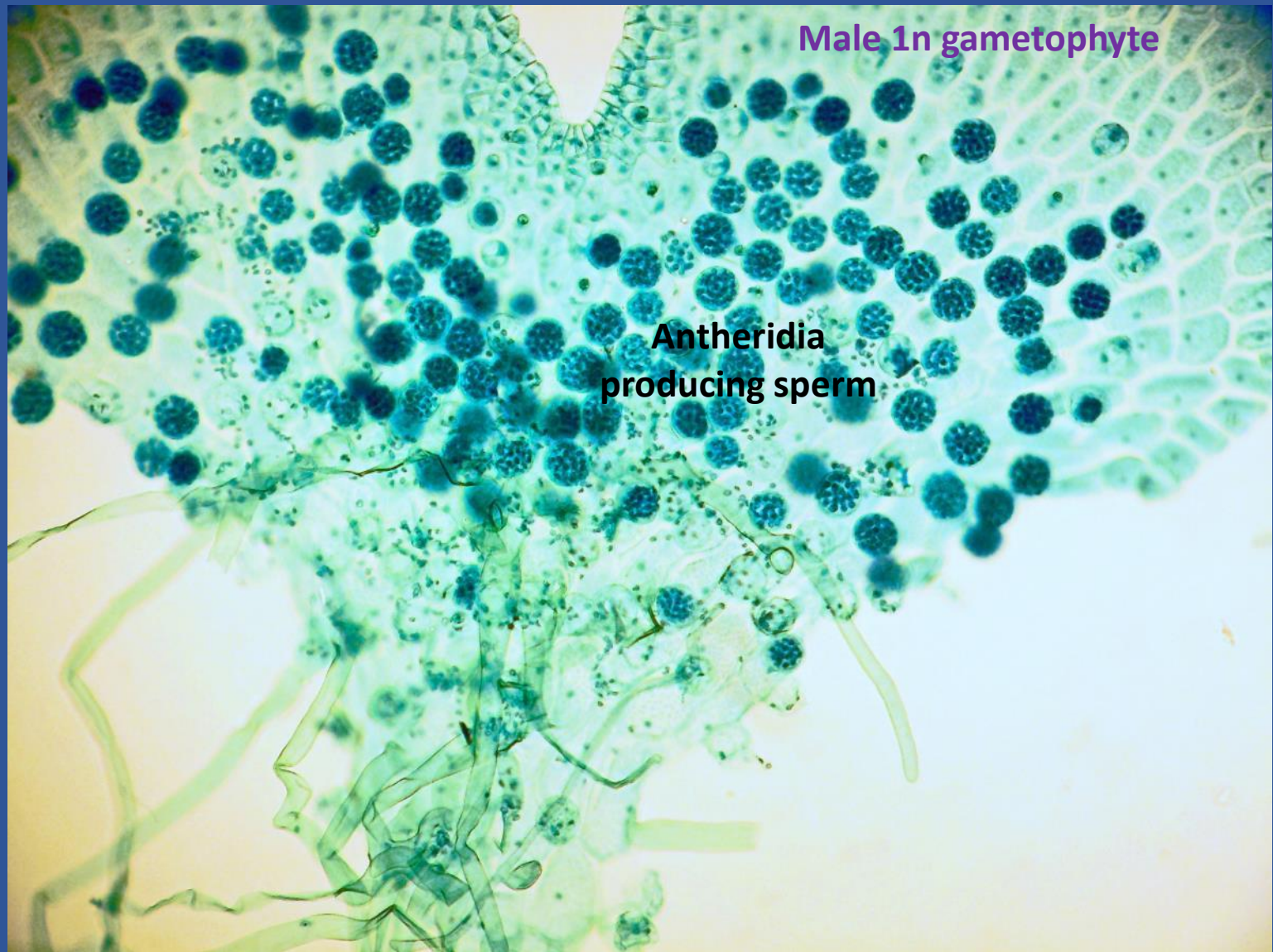
2 young sporophytes



Gametophytes
with antheridia
& archegonia

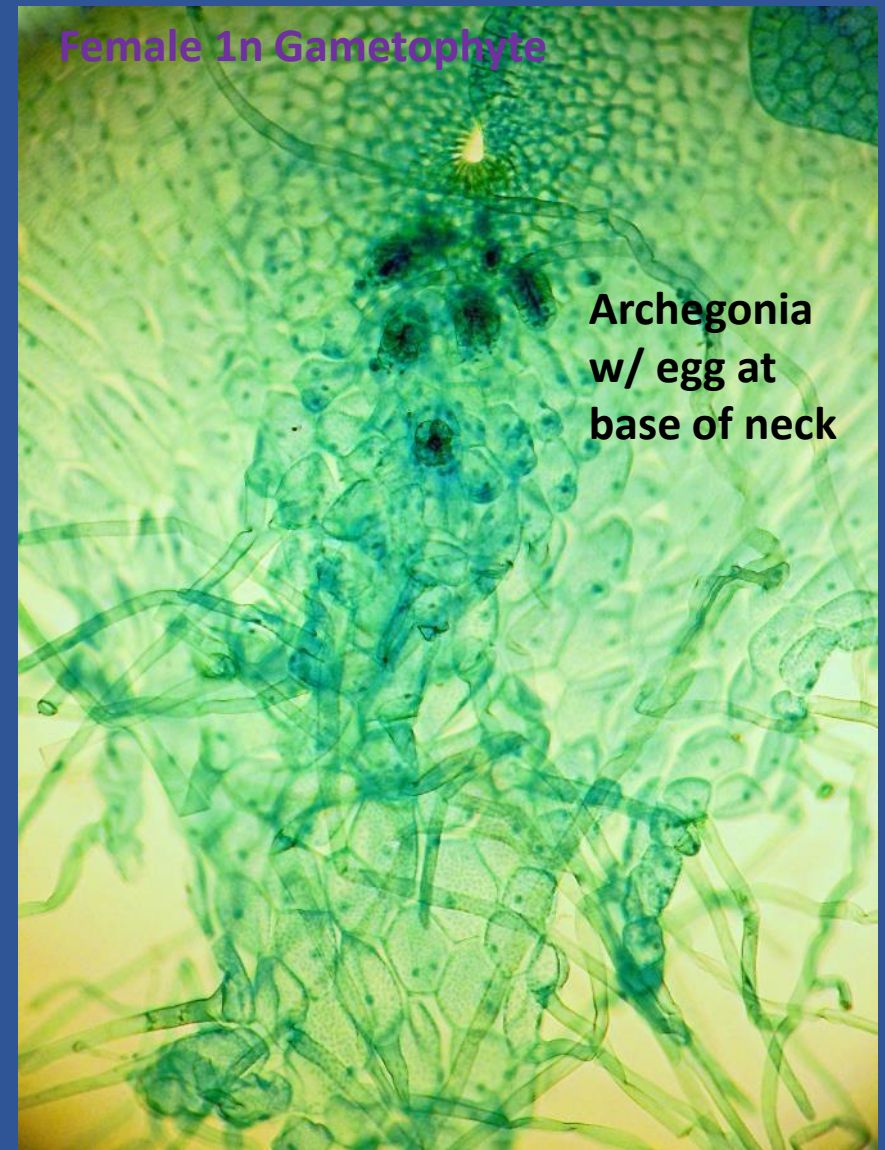


young sporophyte



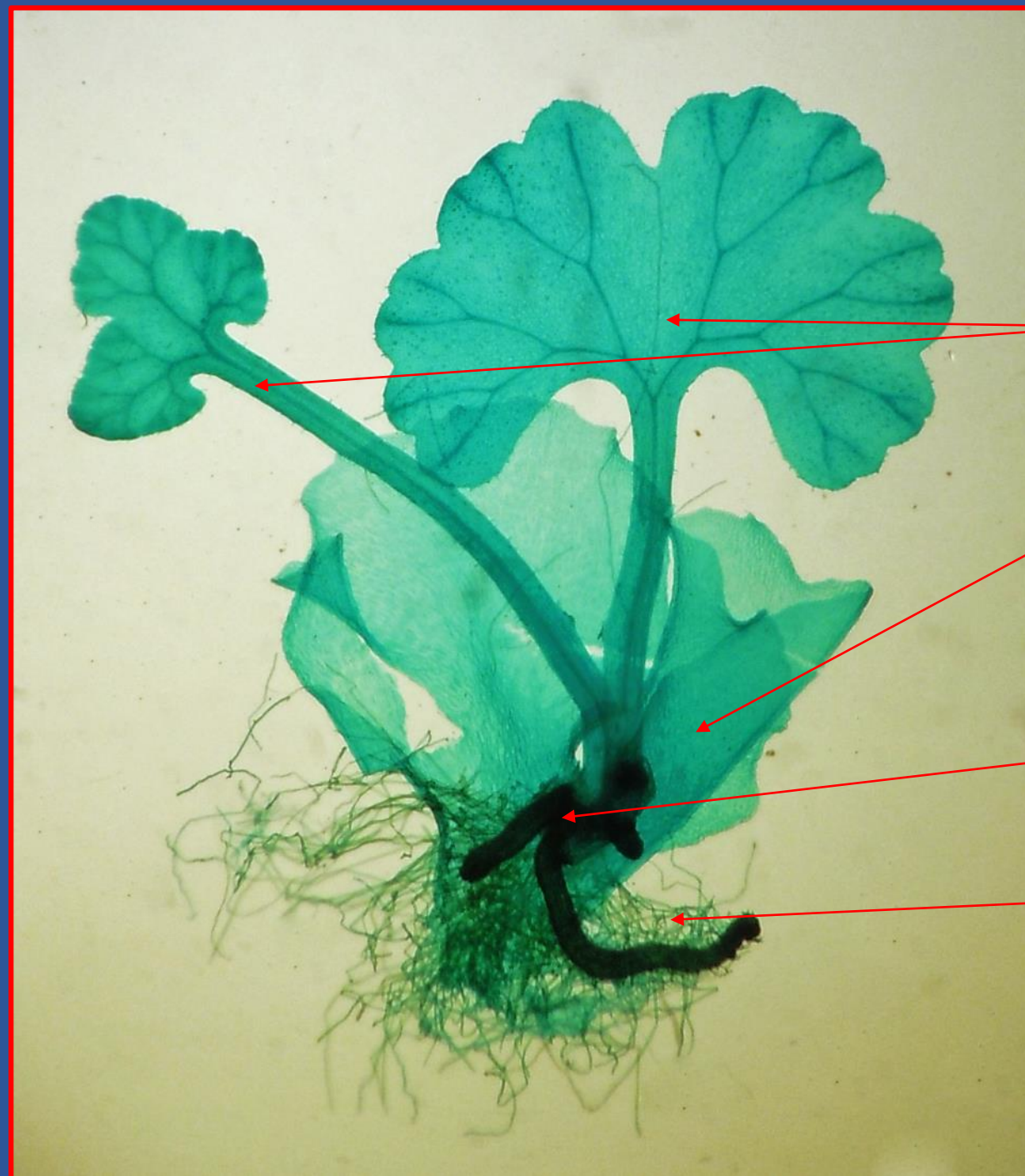
Male 1n gametophyte

Antheridia
producing sperm



Female 1n Gametophyte

Archegonia
w/ egg at
base of neck



Sporophyte ($2n$ from zygote of fertilized egg in old archegonia)

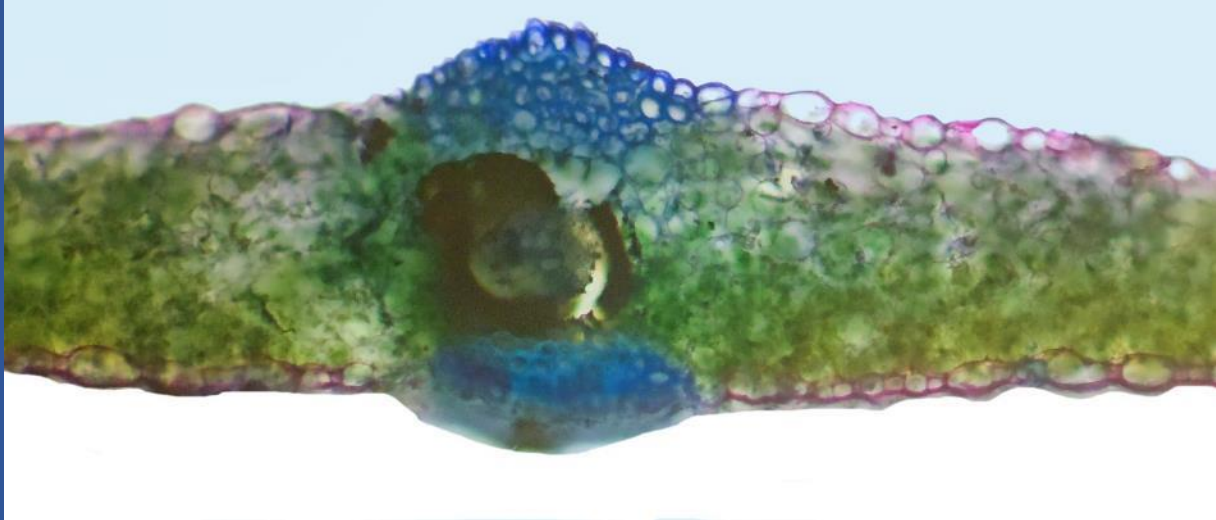
Gametophyte (from $1n$ germinated spore) remains tiny and withers

Rhizome

Rhizoids



Frond (leaf)



Frond (leaf)

Sporangia
No indusium
in this species

Pteridium



Upper epidermis & cuticle

Palisades Mesophyll

Spongy Mesophyll

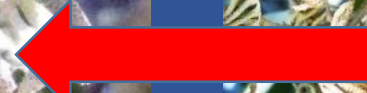
Lower epidermis

Endodermis

Phloem

Xylem

stomata



'Resurrection fern' *Polypodium sp.*



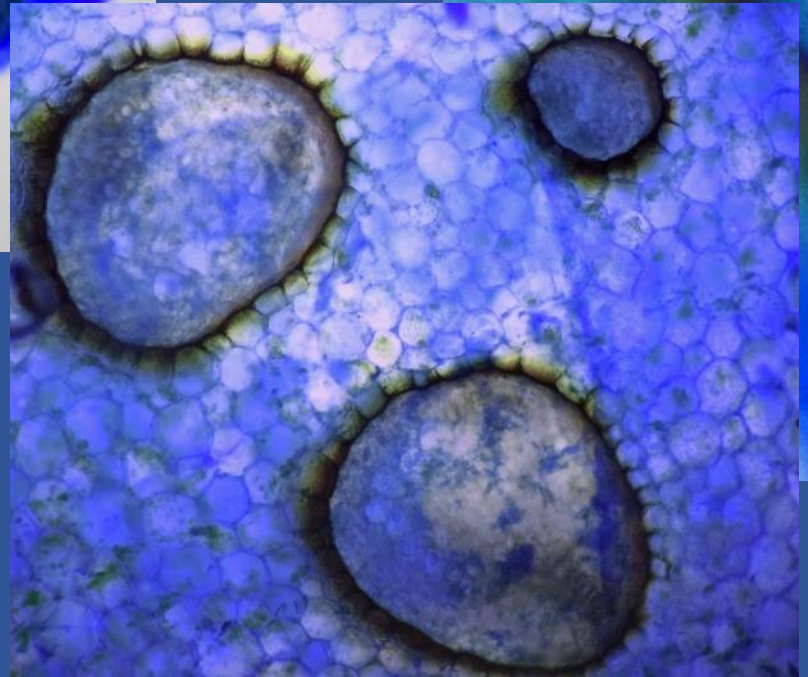
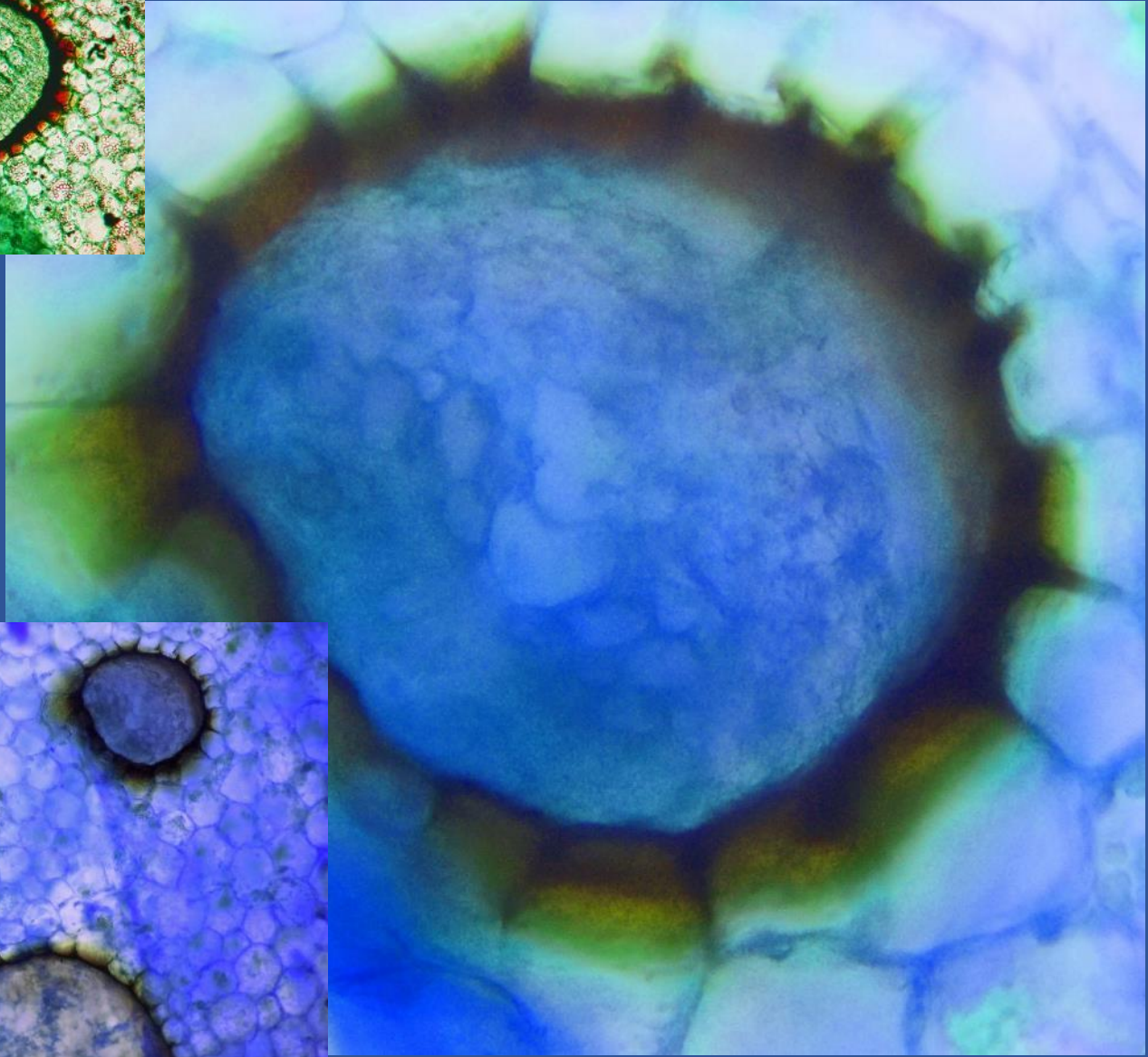
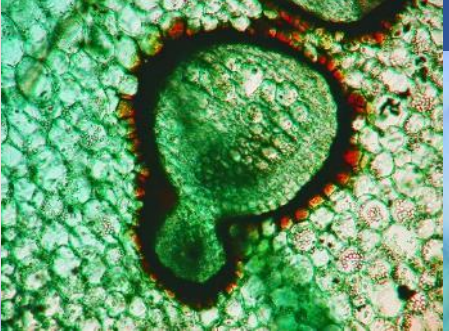
Young and older fiddleheads



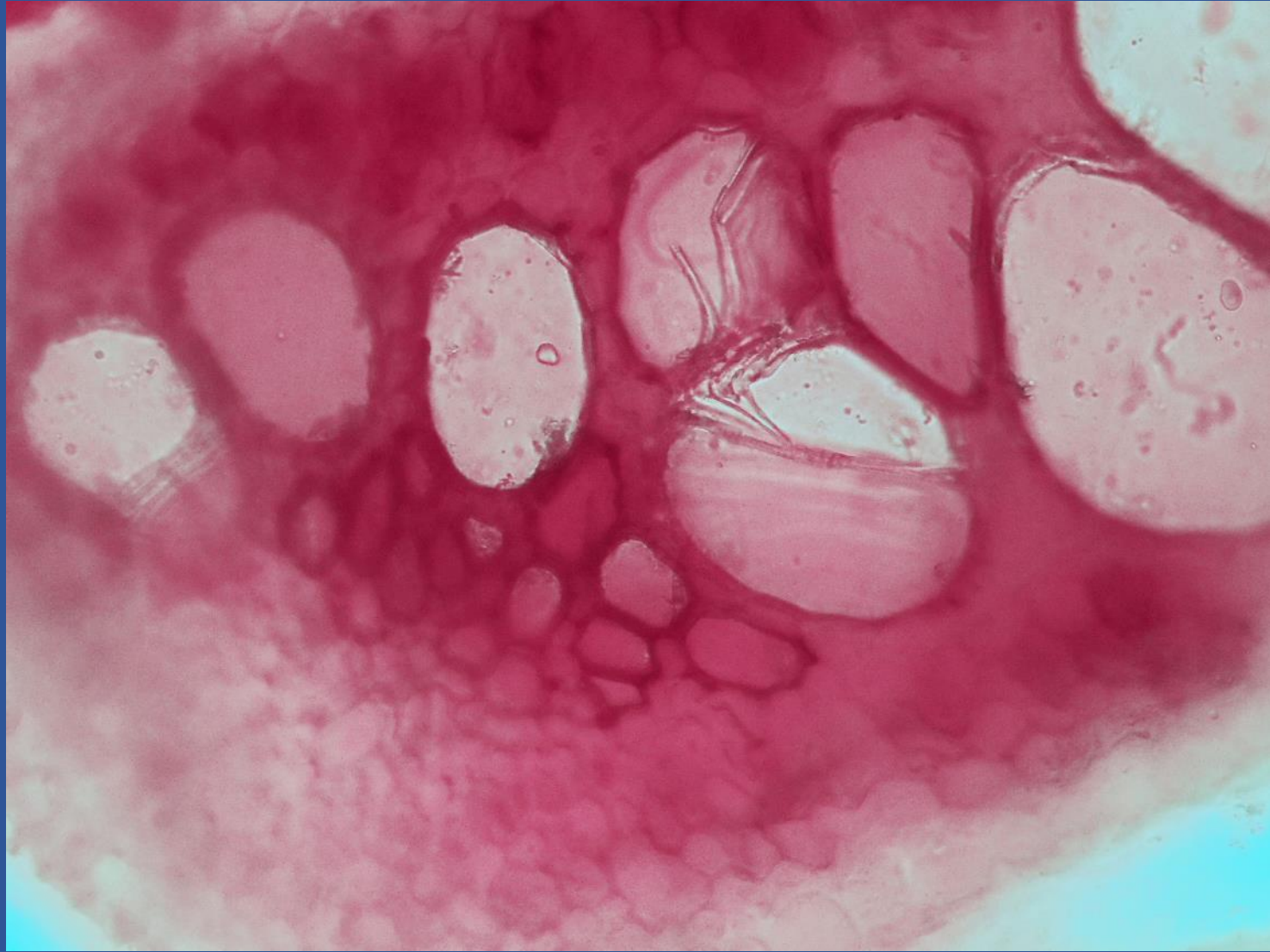
Pinnately compound



'Boston fern': *Nephrolepis* sp.



Vascular bundles in petiole of leaf: Pinnately compound



Fern vascular bundles

Fern
Rhizome
w/
Vascular
Bundles



CS Rhizome
of Fern

Endodermis
Phloem
Xylem



Tree fern:
S.E. Asia

Leaf:
compound
- doubly
pinnate or
bipinnate



large
fiddlehead

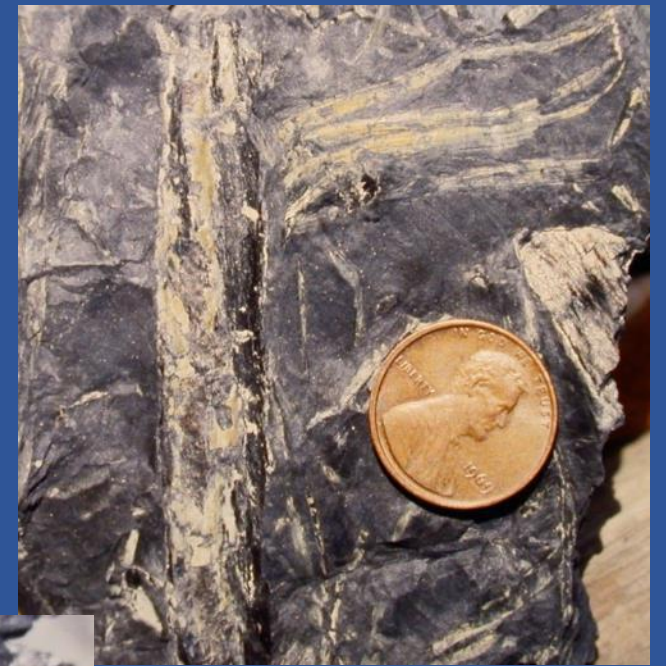
Seed ferns



Seed ferns



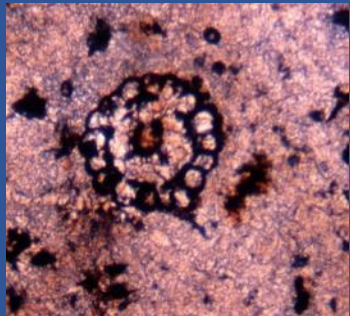
Seed ferns



Permian & Pennsylvanian
Period fossil fern allies



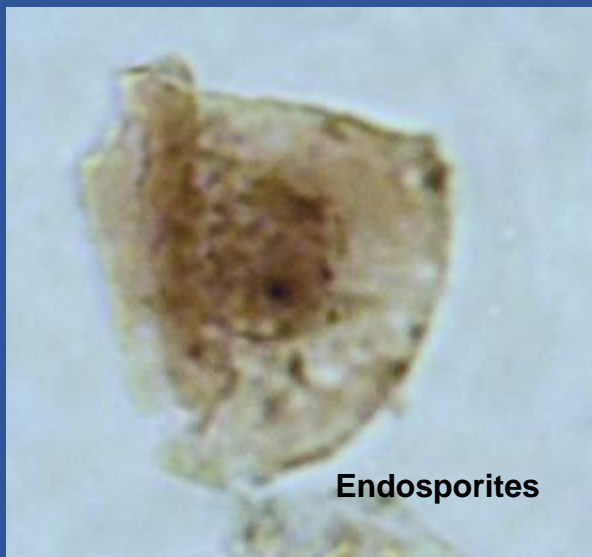
Seed ferns



Sphenopsid stem:
coal ball acetate
peel



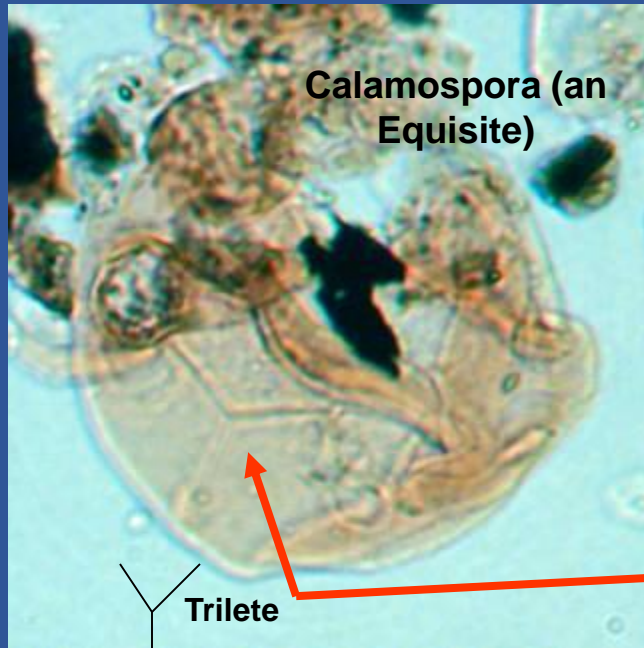
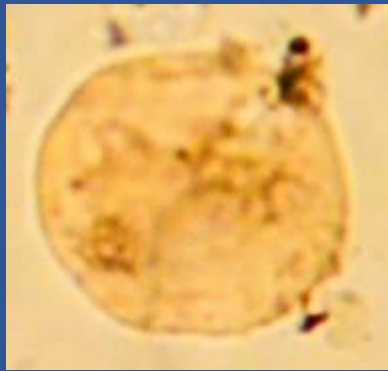
See 'COAL' web
page on this site



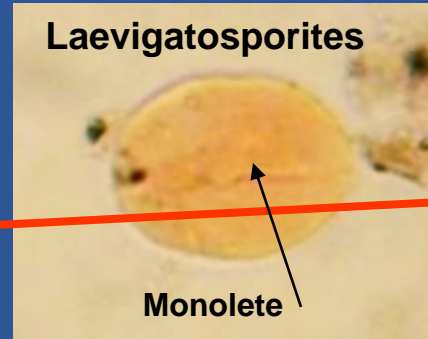
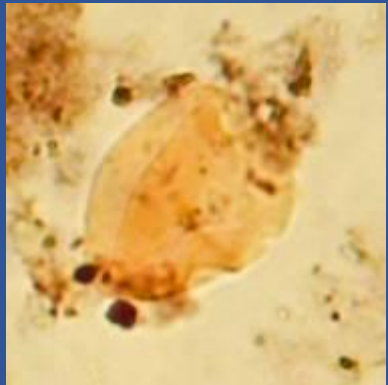
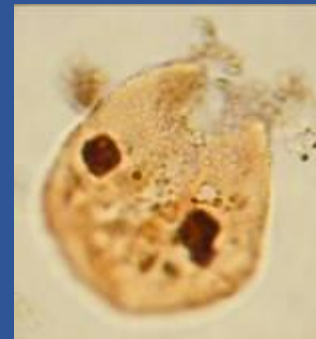
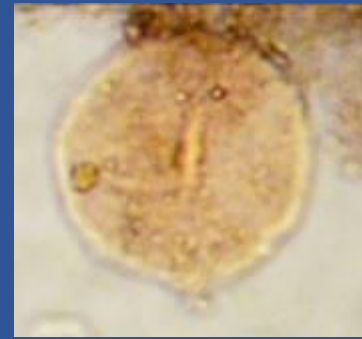
Endosporites

To see reproductive methodology of primitive GYMNOSPERMS (like cordaites and seed ferns) see presentation on *Cycads* on this web site

Plant Group	relative import in Pennsylvanian			Palynomorph Genera
	Lower	Mid	Upper	
Lycopods	x	x		<i>Endosporites</i> , <i>Crassispora</i> and <i>Lycospora</i>
Seed Ferns tree-like <i>Psaronius</i> & Medullosans: Pteridosperms		x	x	<i>Laevigatoporites</i> (small) and <i>Thymospora</i> monoletes
Sphenopsids:		x	x	<i>Laevigatoporites</i> (large) and <i>Calamospora</i>
Cordaites		x		<i>Florinites</i>

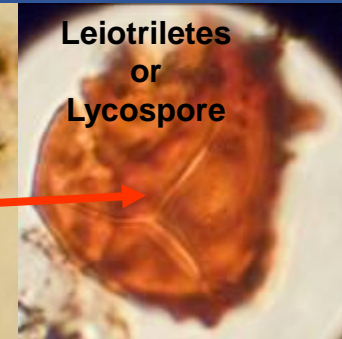


Calamospora (an Equisite)

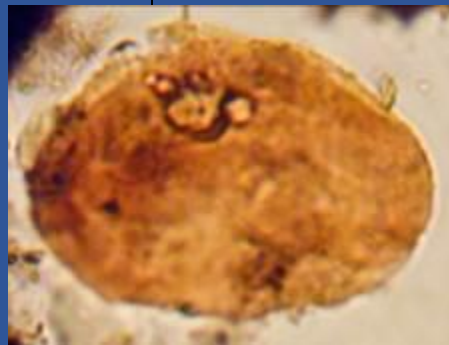


Laevigatosporites

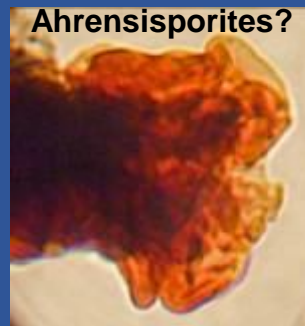
Monolete



Leiotriletes or Lycospore



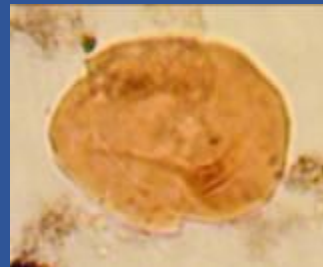
Laevigatosporites



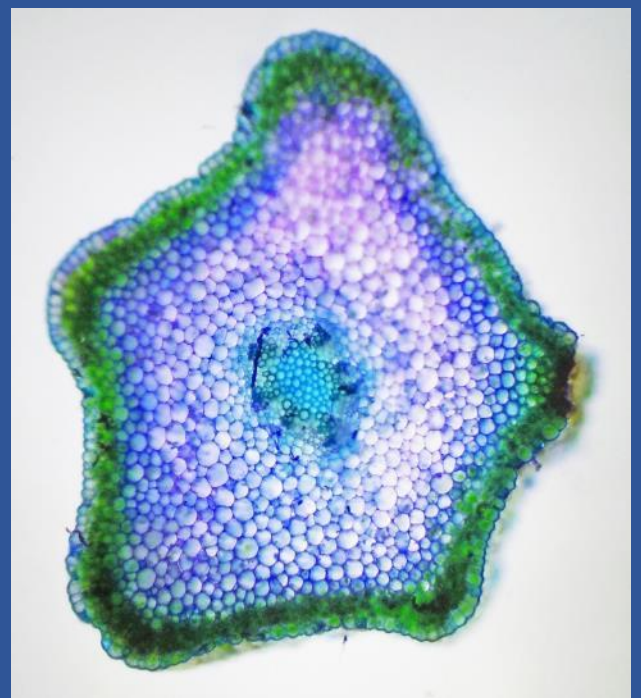
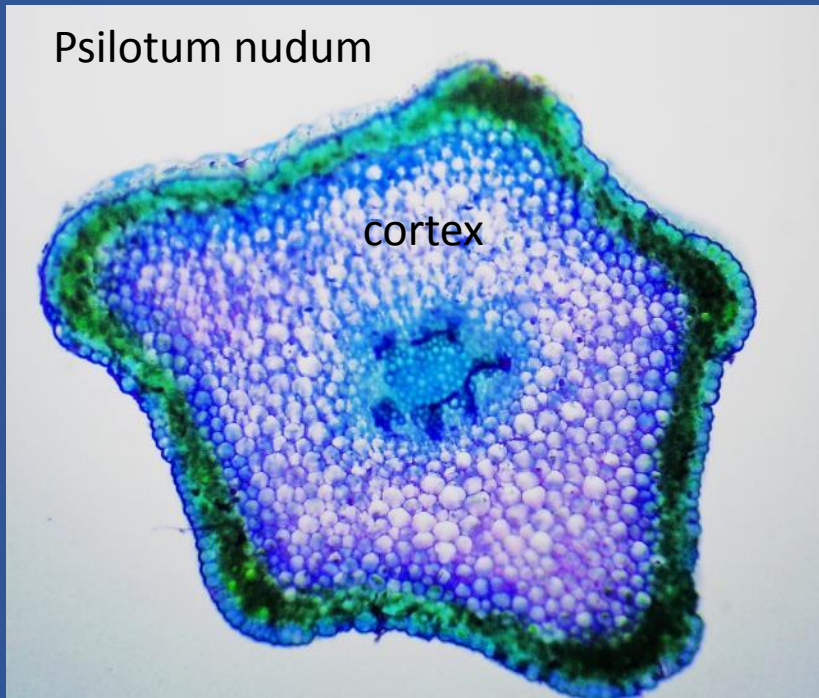
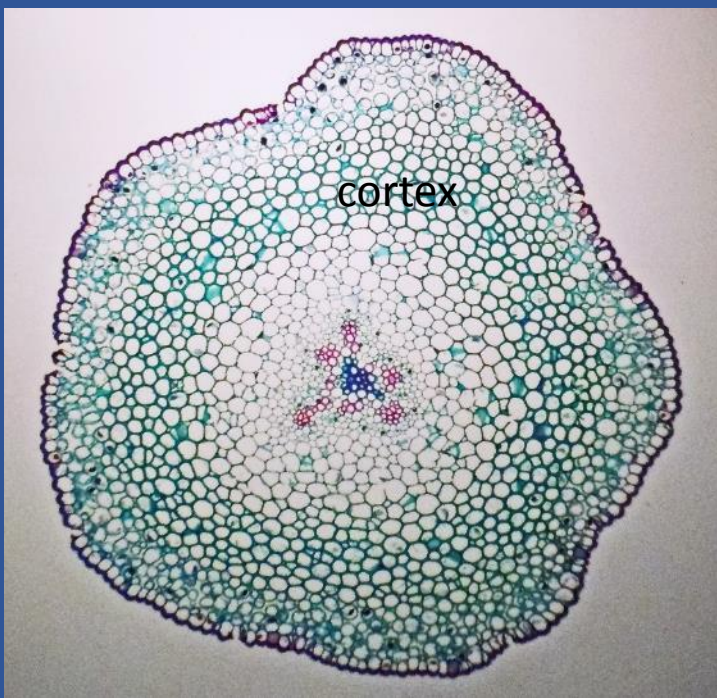
Ahrensisporites?



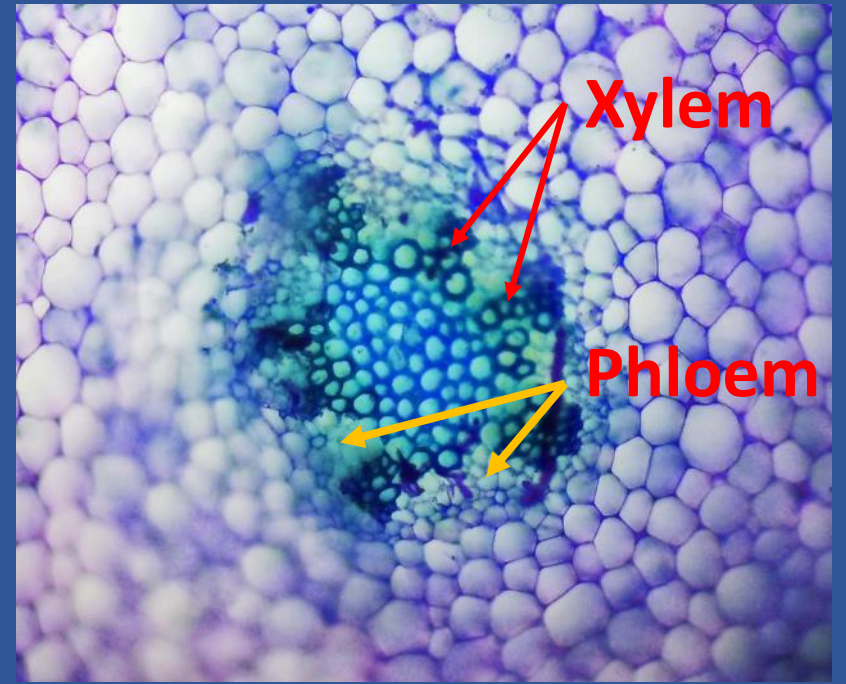
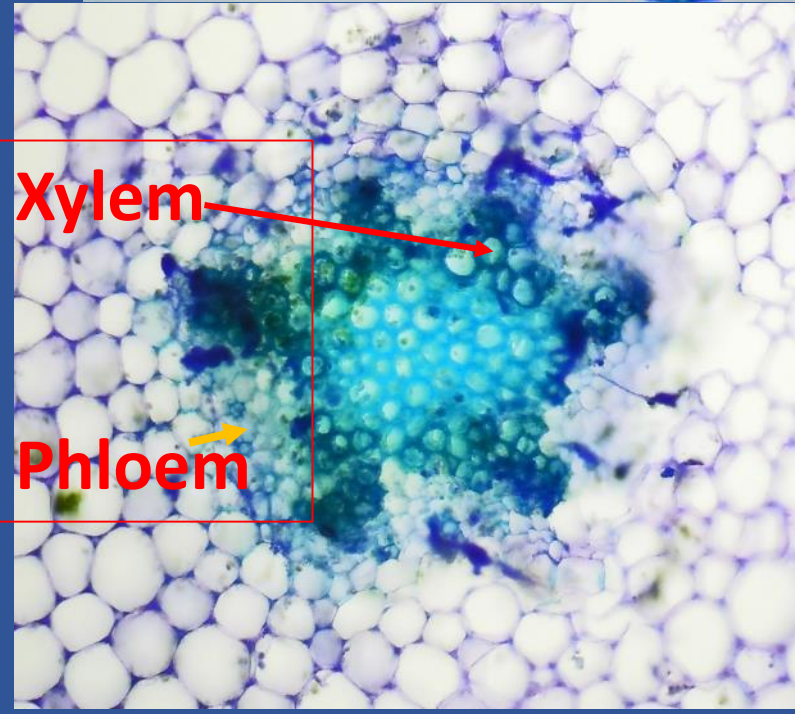
Microreticulatosporites?

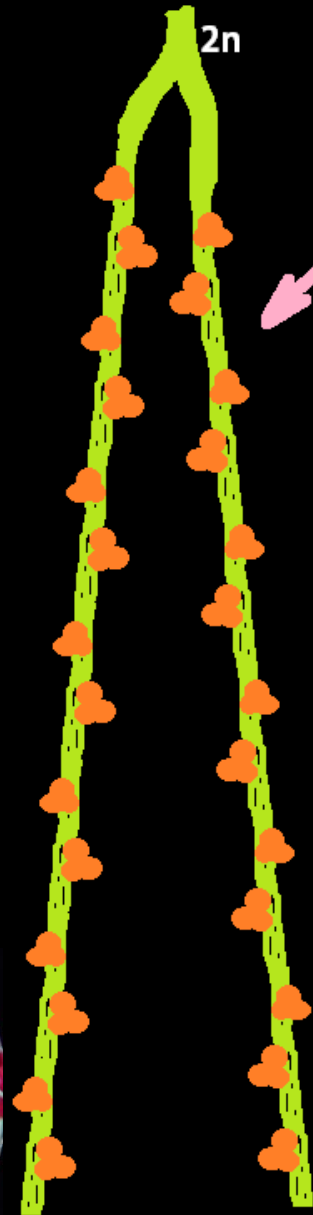
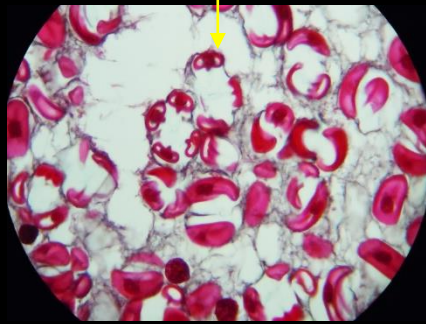
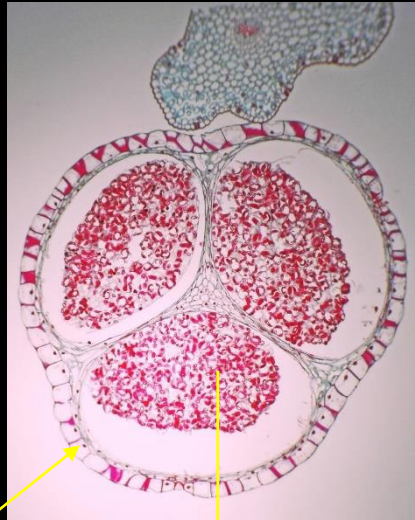


Palynomorphs Dunkard Gp.



stems



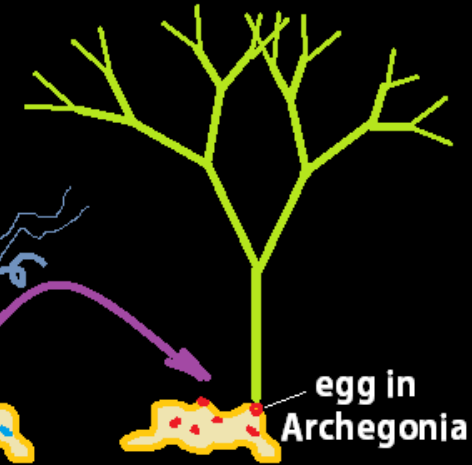


part of mature sporophyte with **sporangia** and **sporocytes** going through **MEIOSIS** to form **SPORES (1n)**



Young $2n$ Sporophyte from fertilized egg (zygote \rightarrow embryo)

swimming sperm from Antheridia



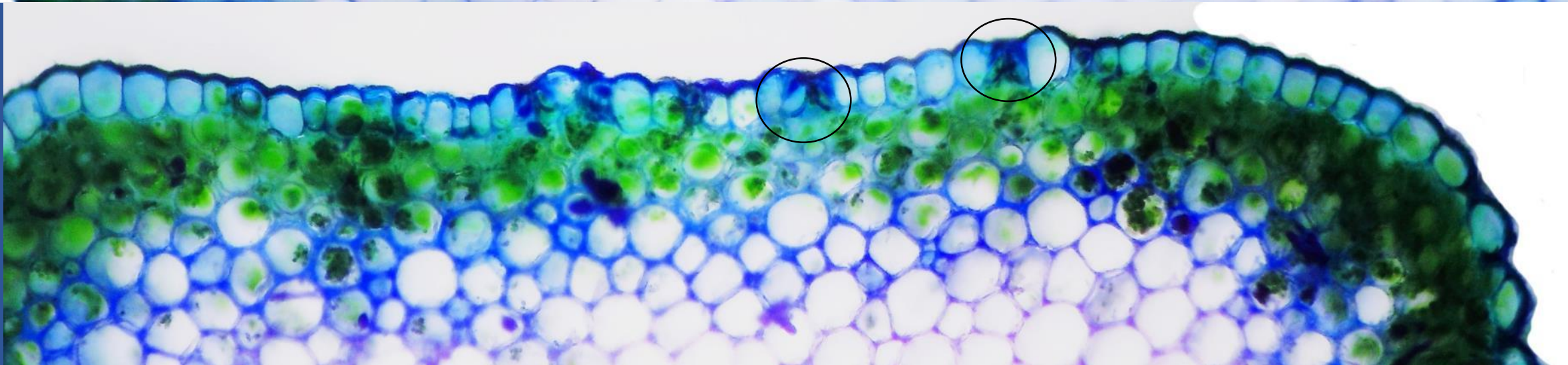
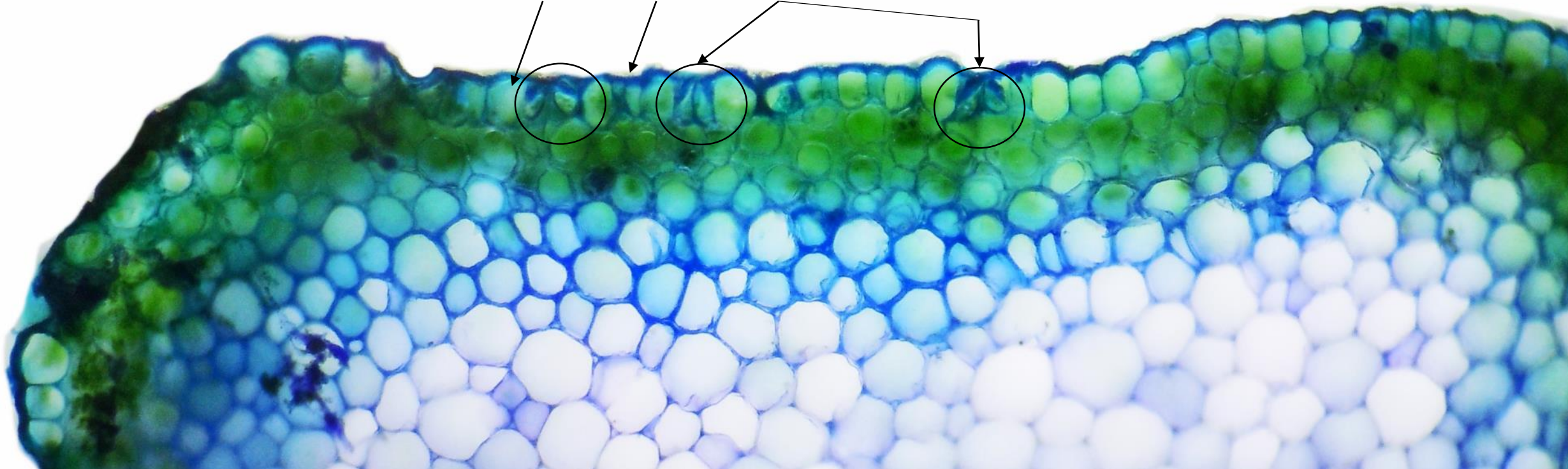
egg in Archegonia

Male & Female gametophytes from $1n$ spores



$1n$ spore

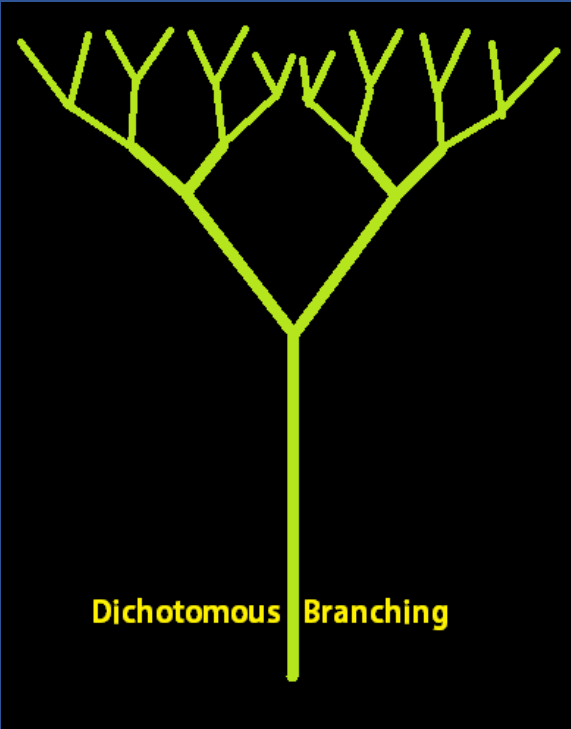
Epidermis + cuticle & STOMATA



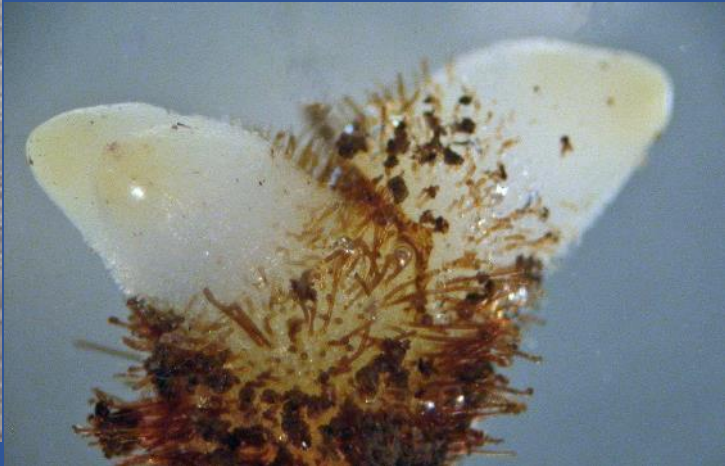
Scales, not
'leaves'

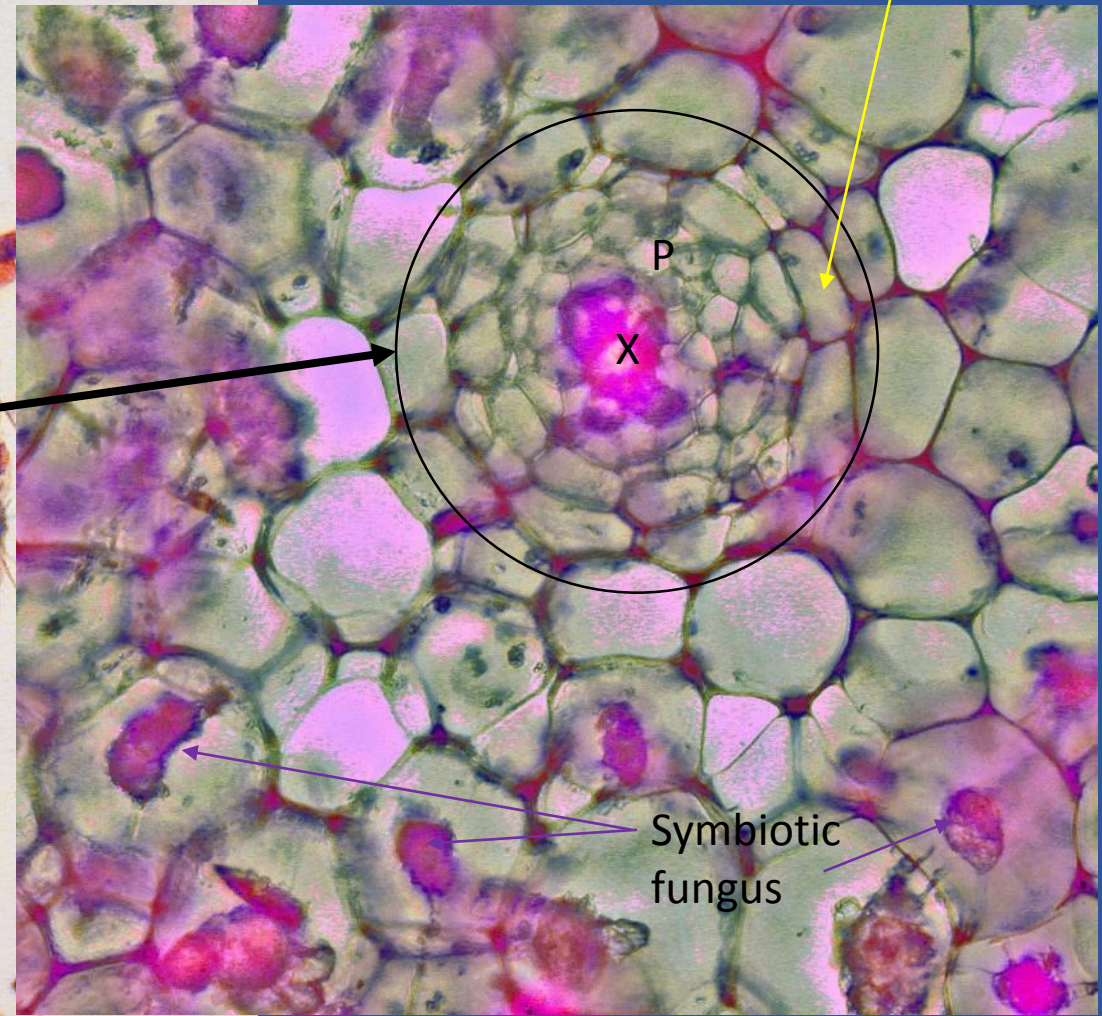
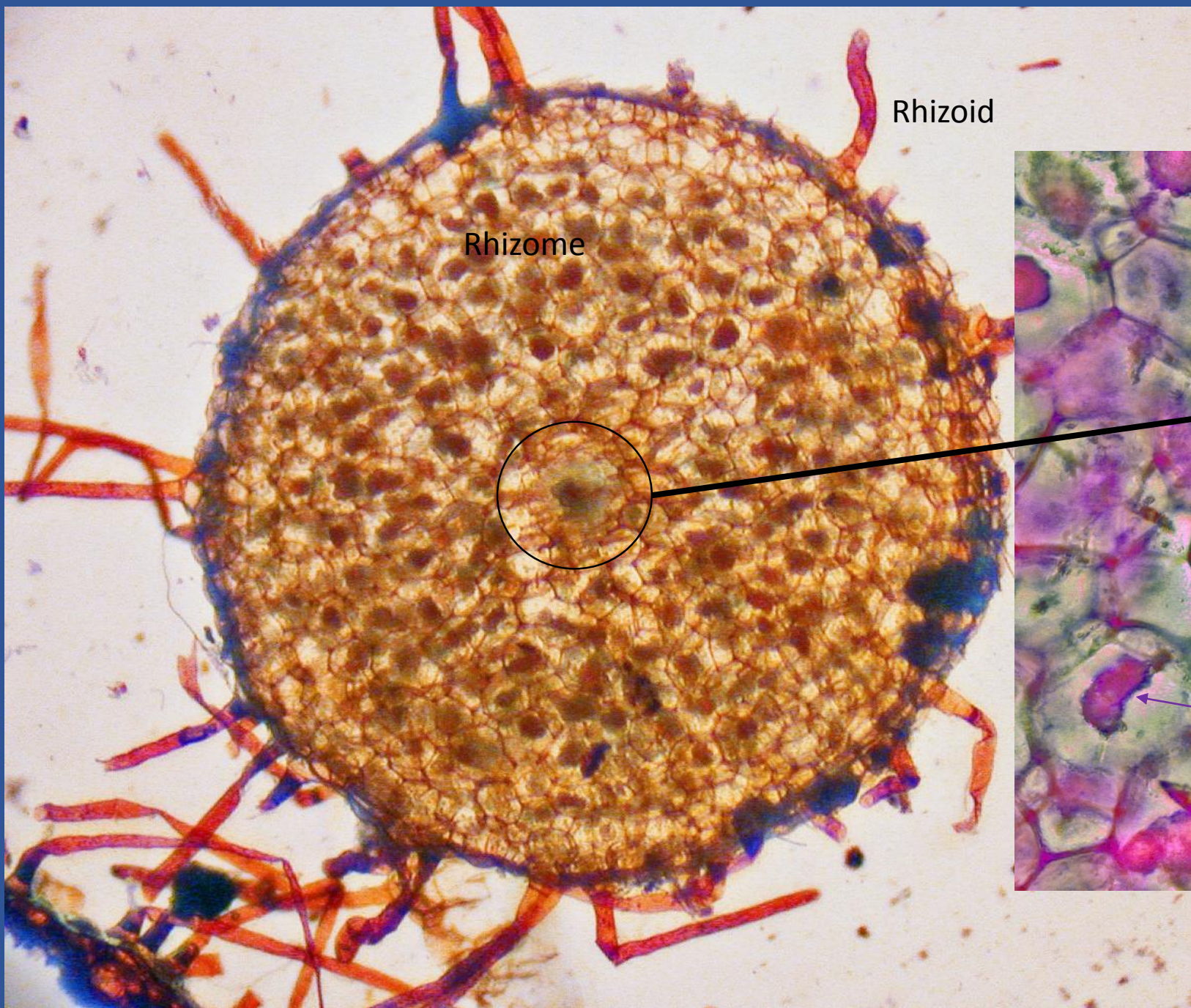


Psilotum: note
dichotomous
branching

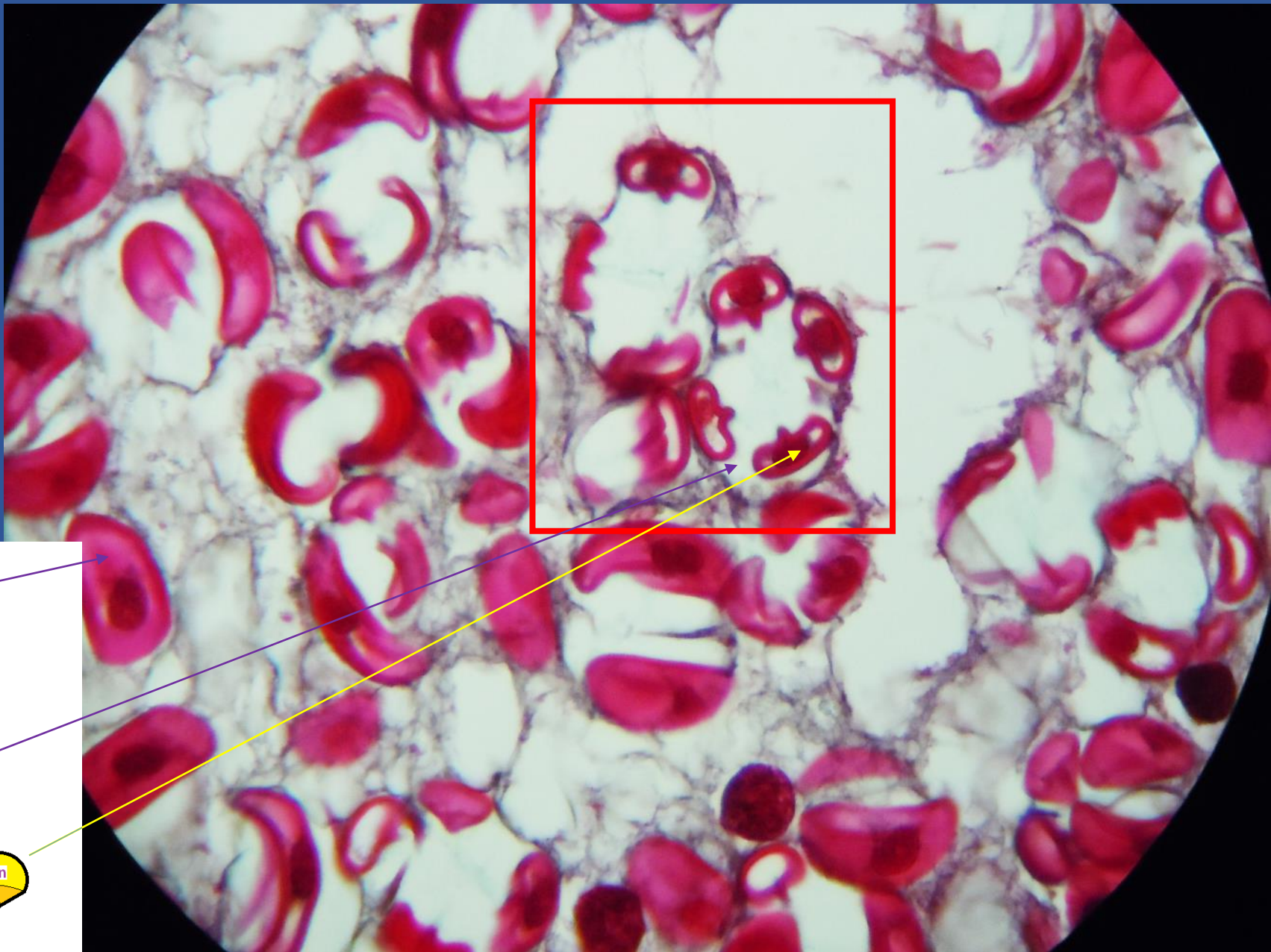


Underground rhizomes
dichotomously branch
too.

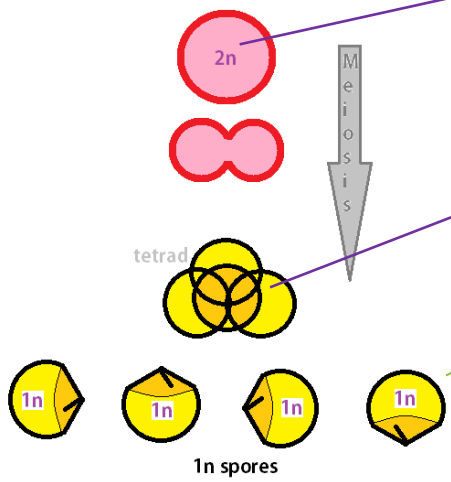








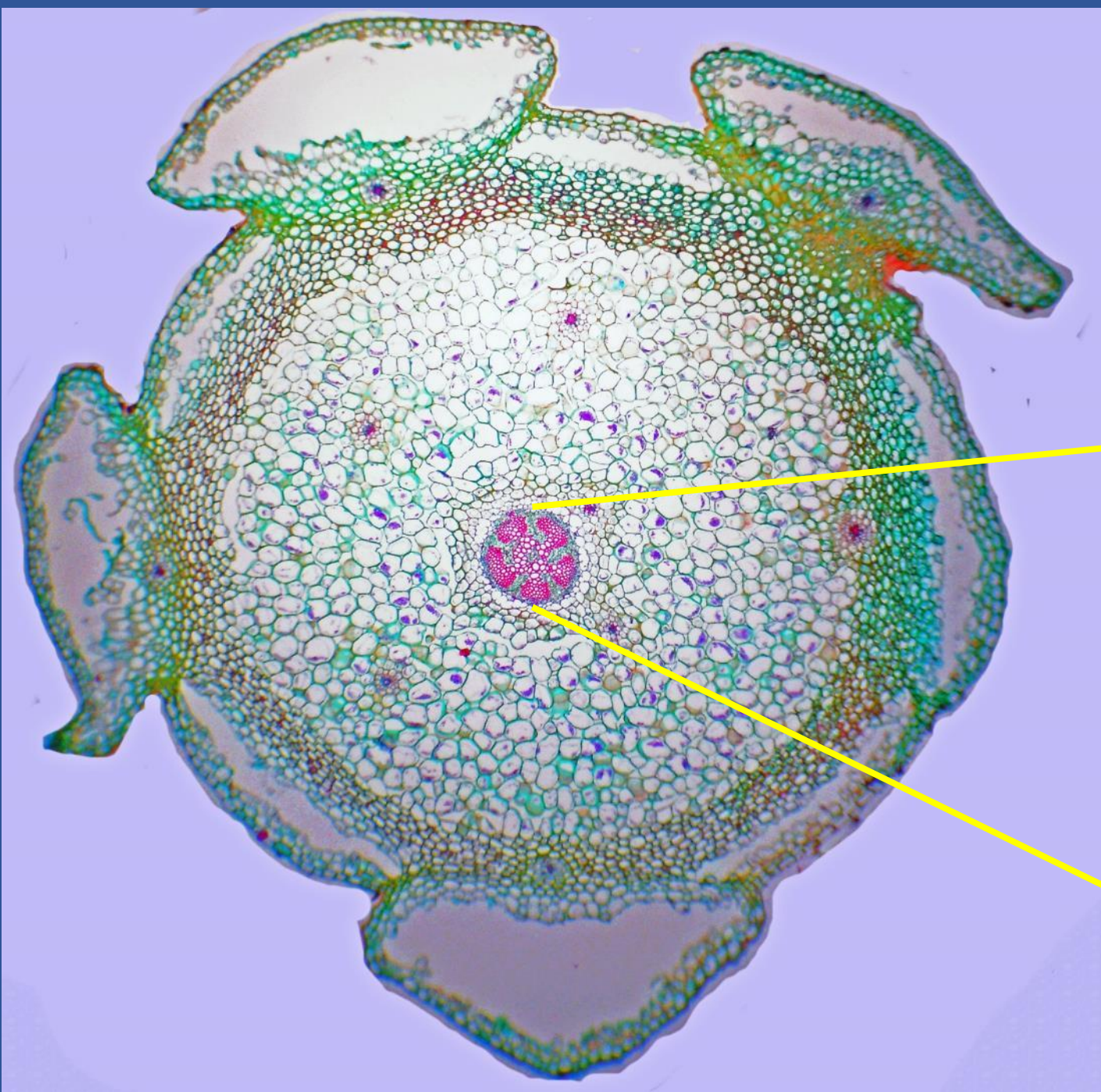
Meiosis in
sporangium
to form 1n
spores



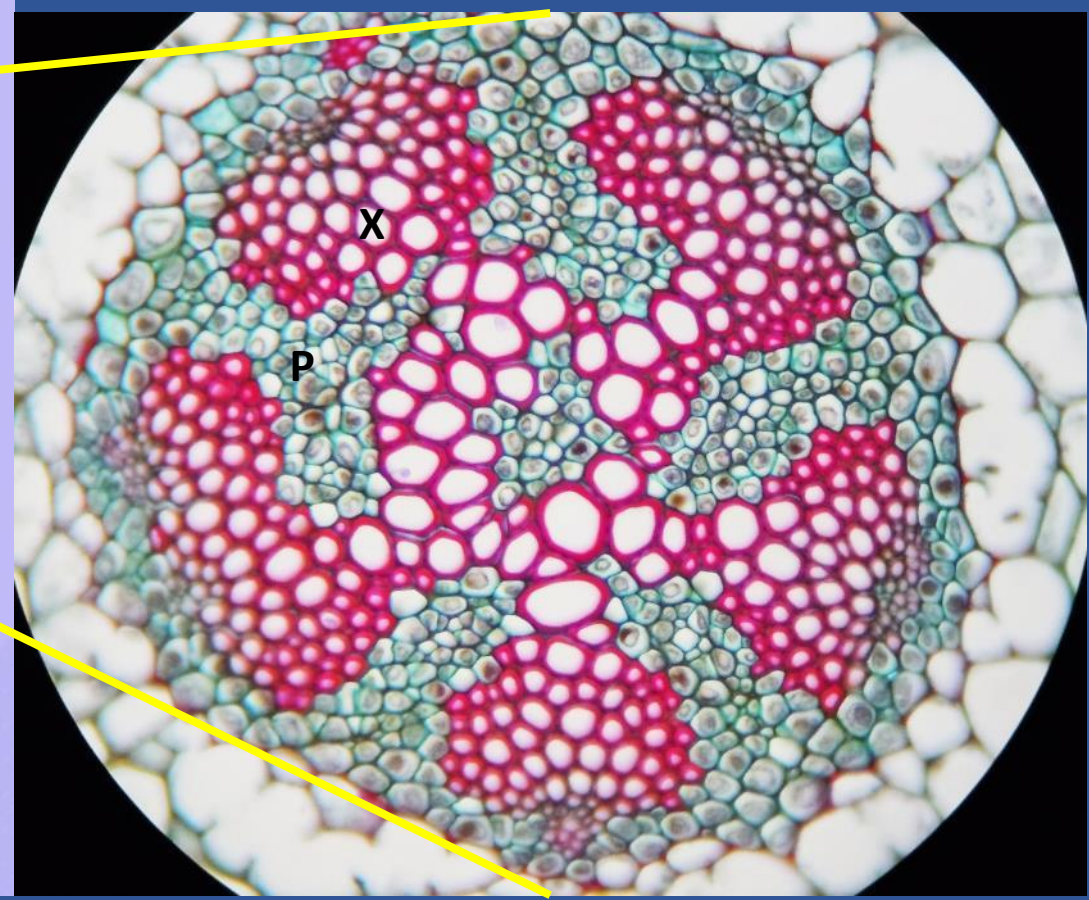


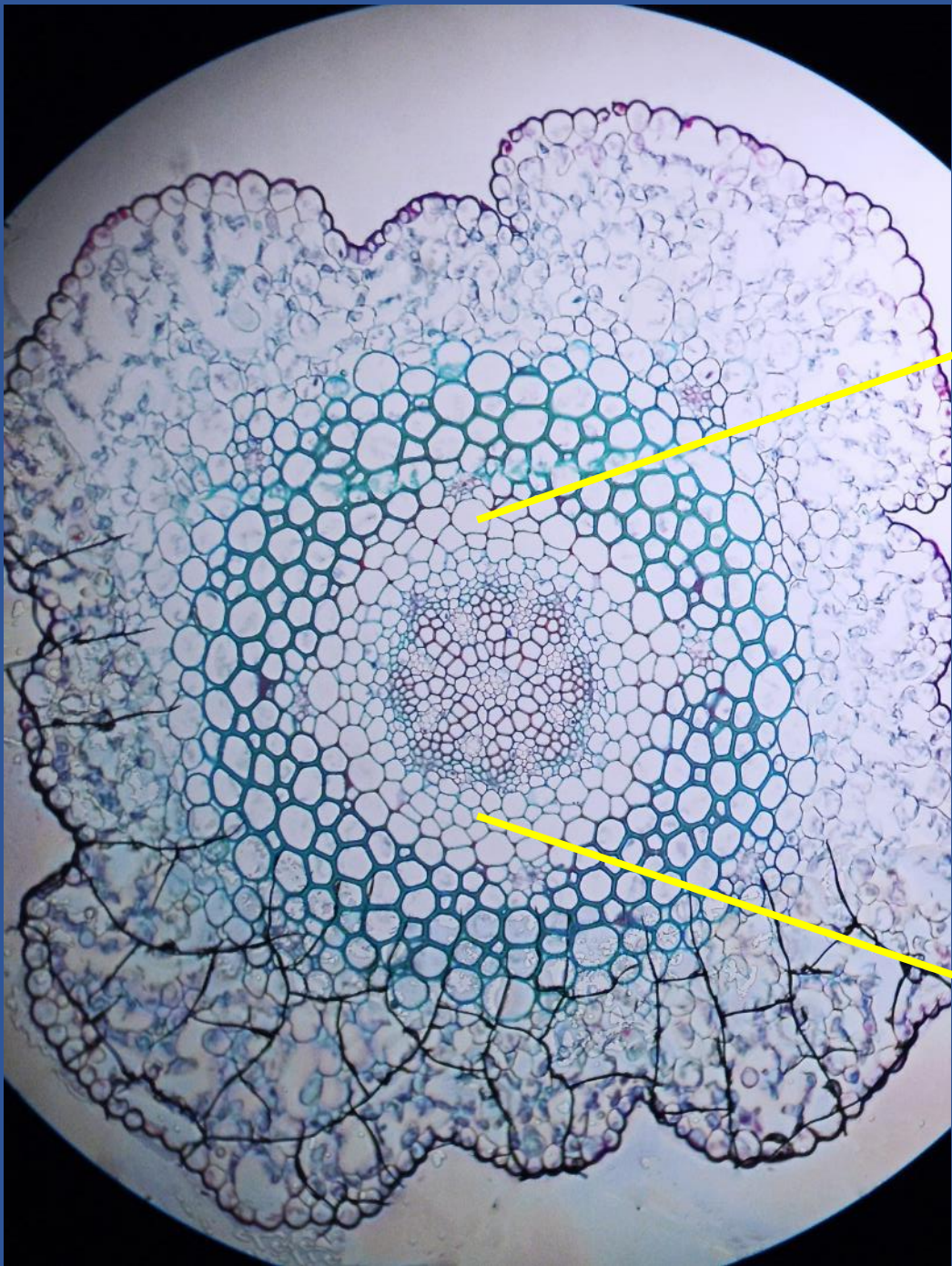
**Lycopodium (Homosporous):
club 'moss'**



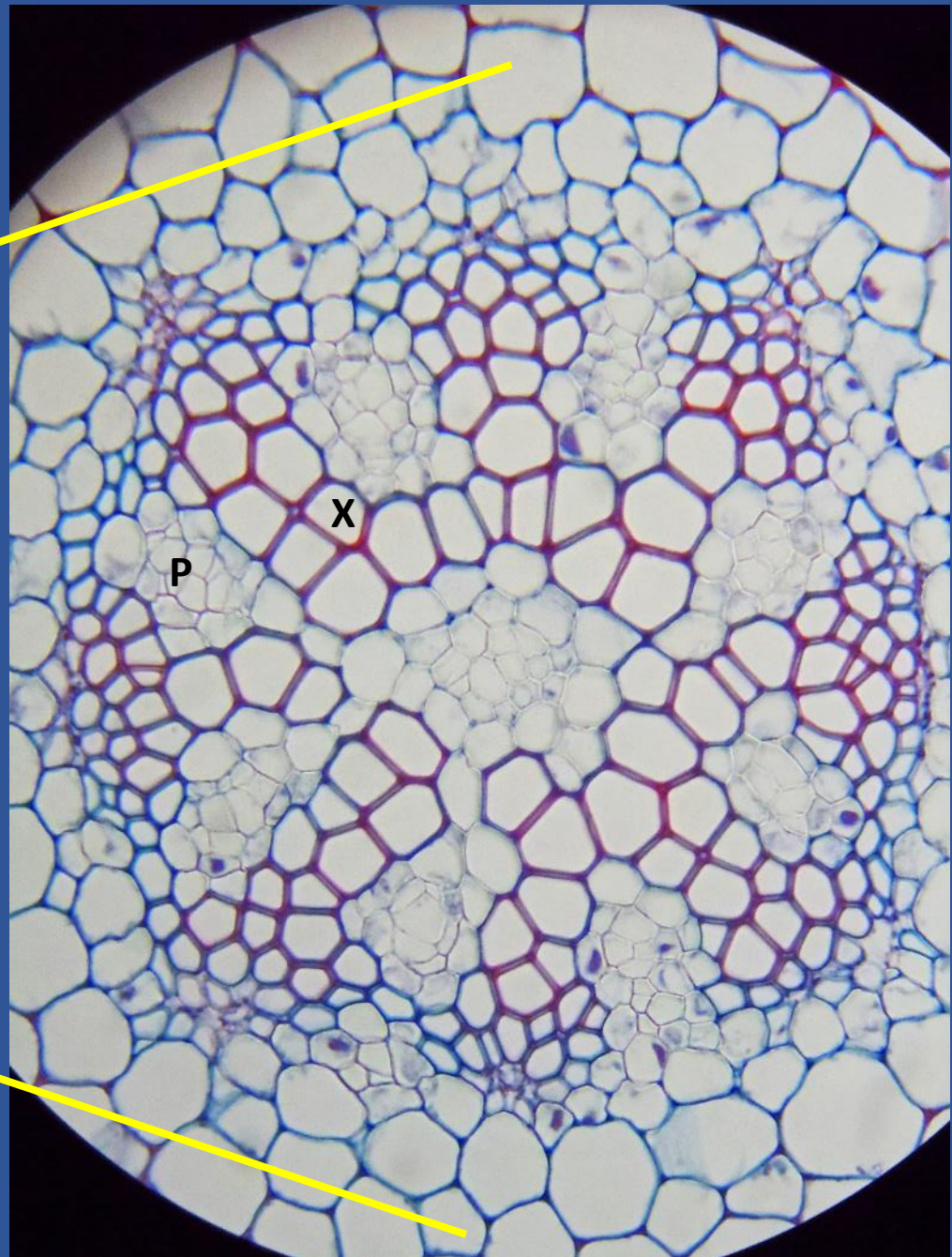


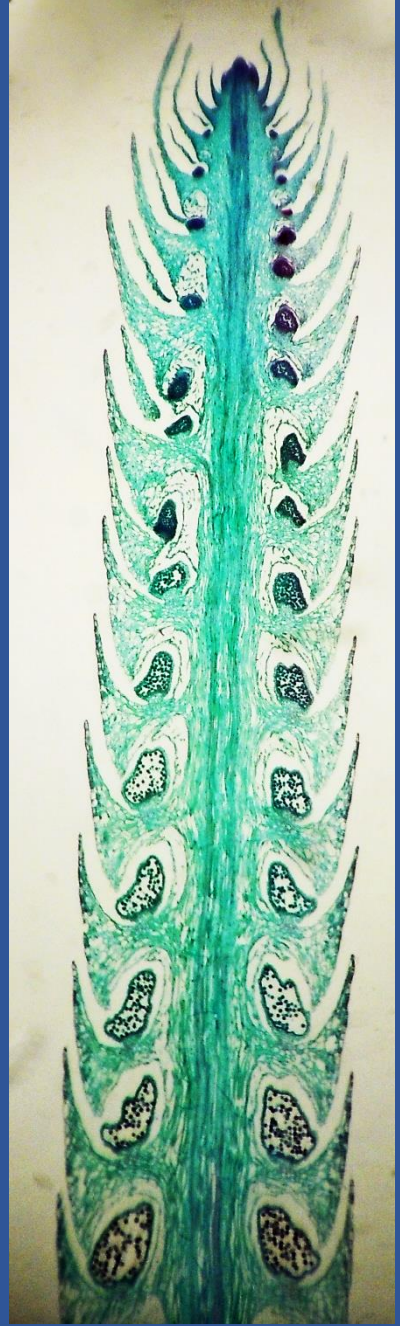
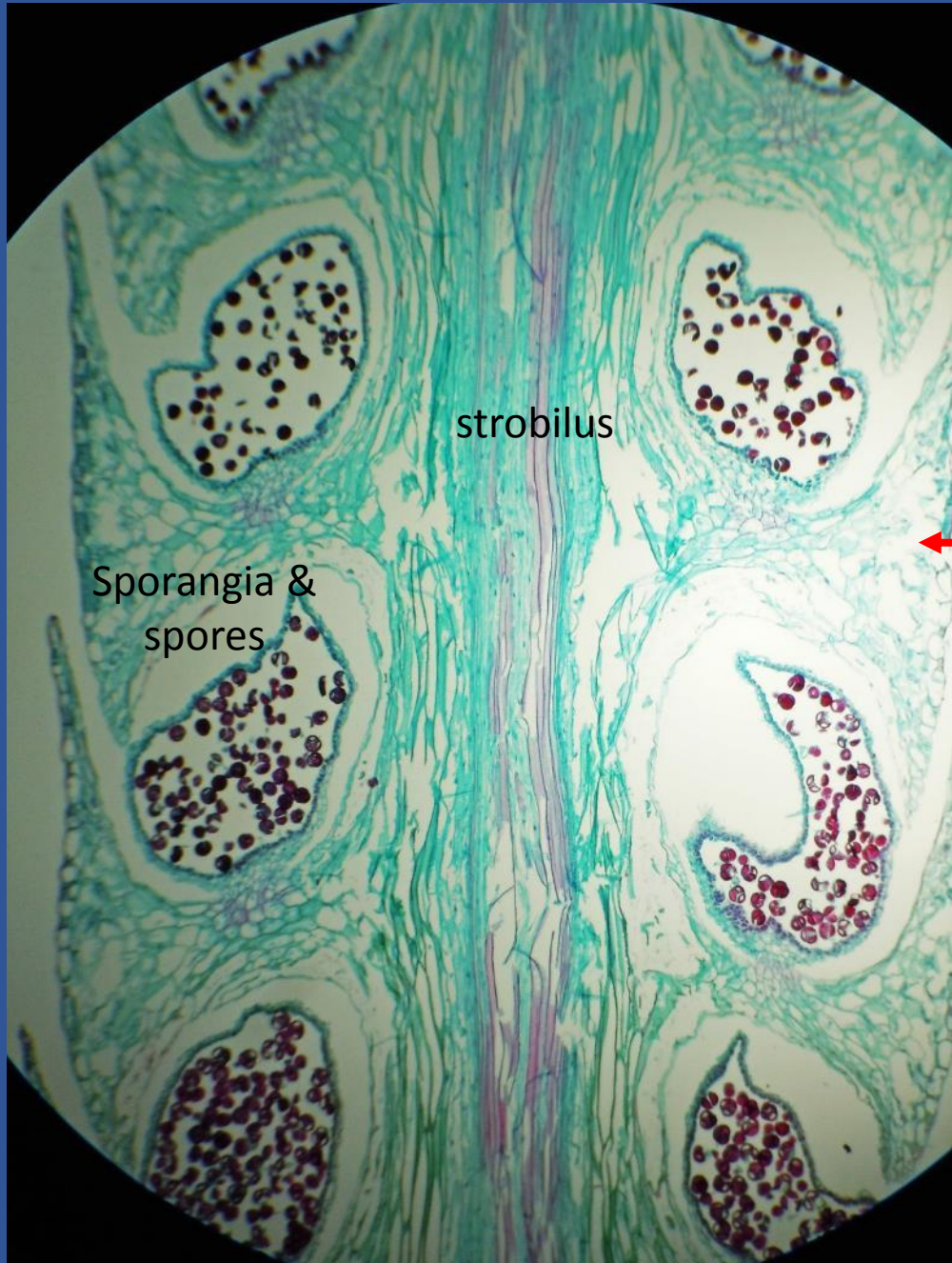
Lycopodium;
Stem with
'leaves'





Lycopodium:
stem

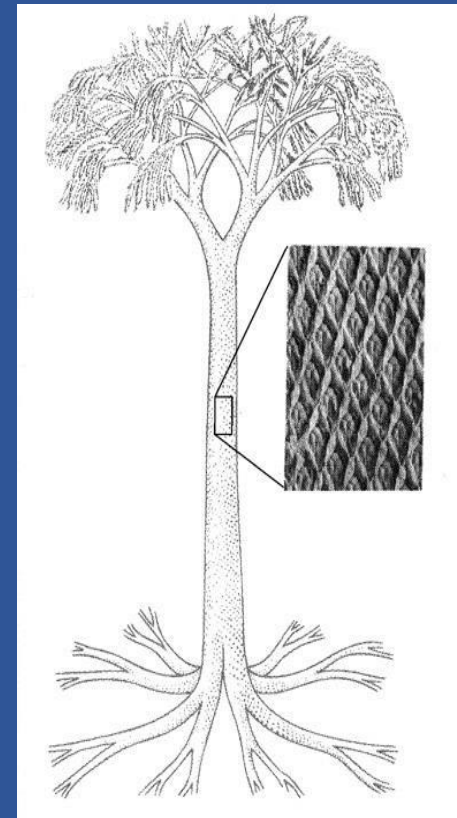




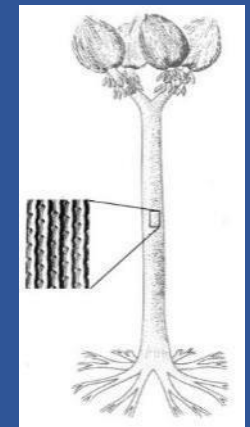
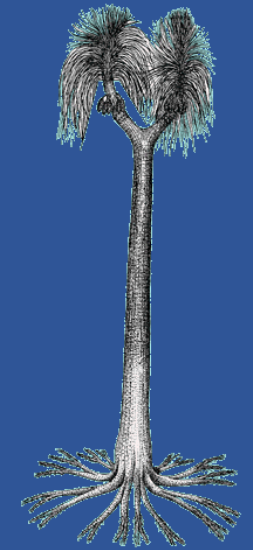
LYCOPODS



Lepidophylloides on
twig of
Lepidodendron

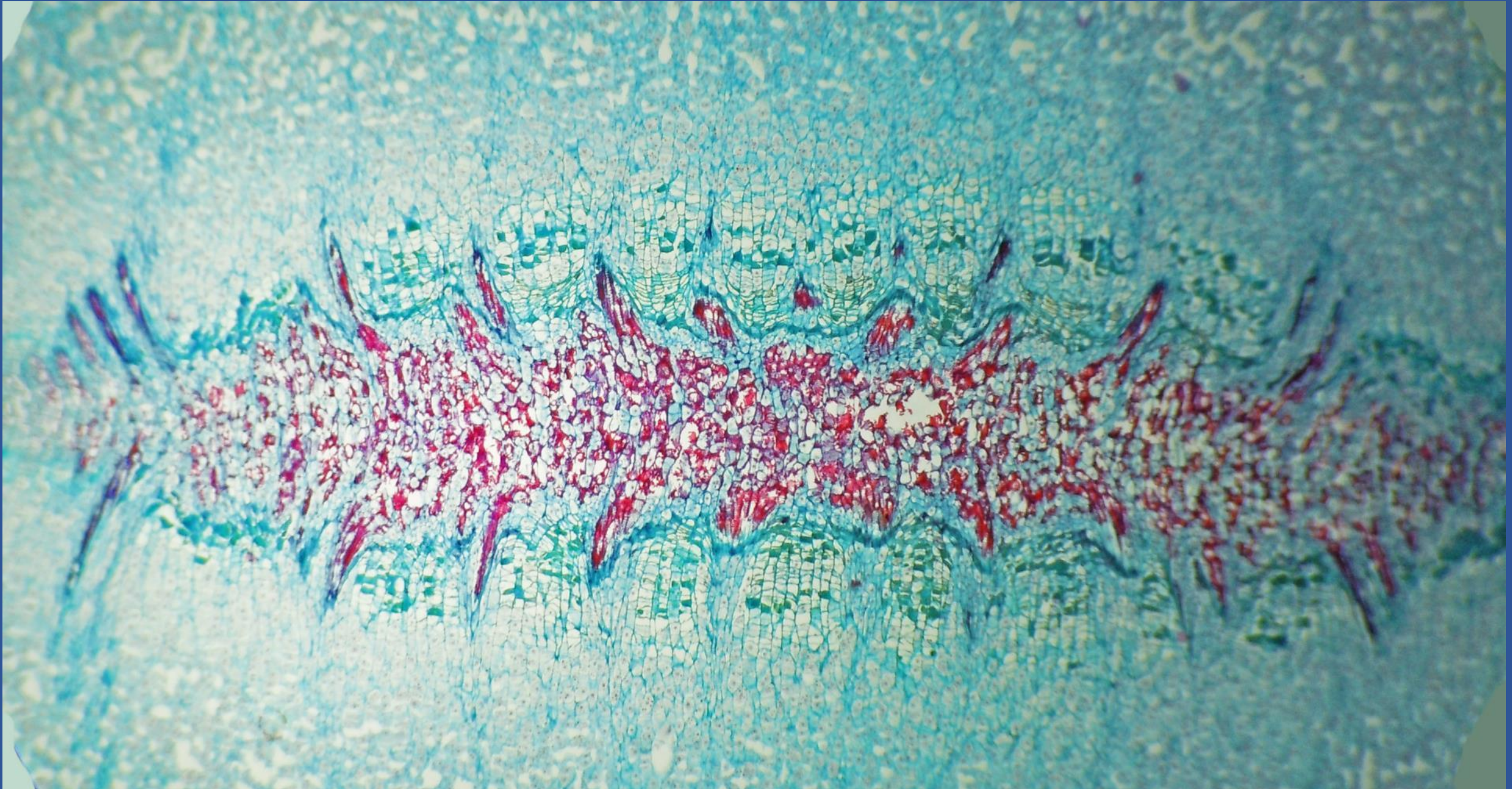


LYCOPODS:

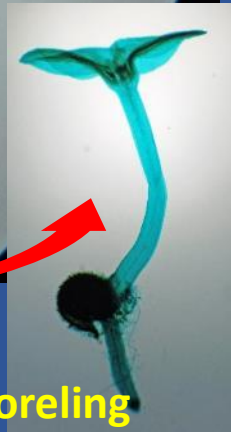
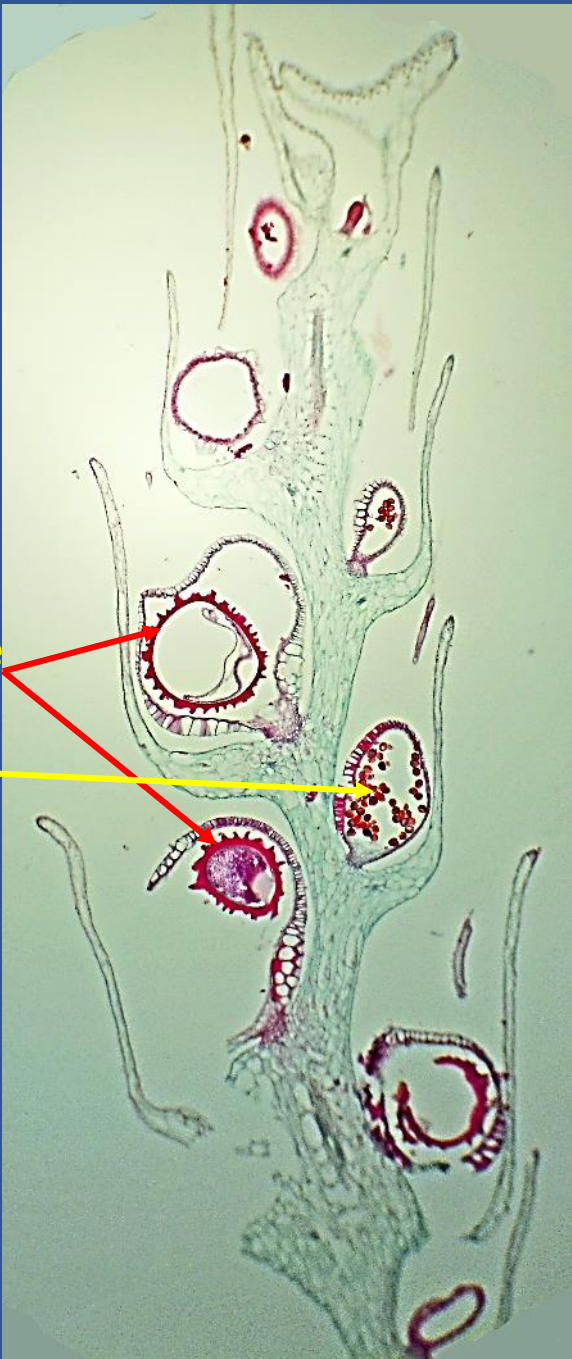


Stigmaria ('root' of *Lepidodendron*)

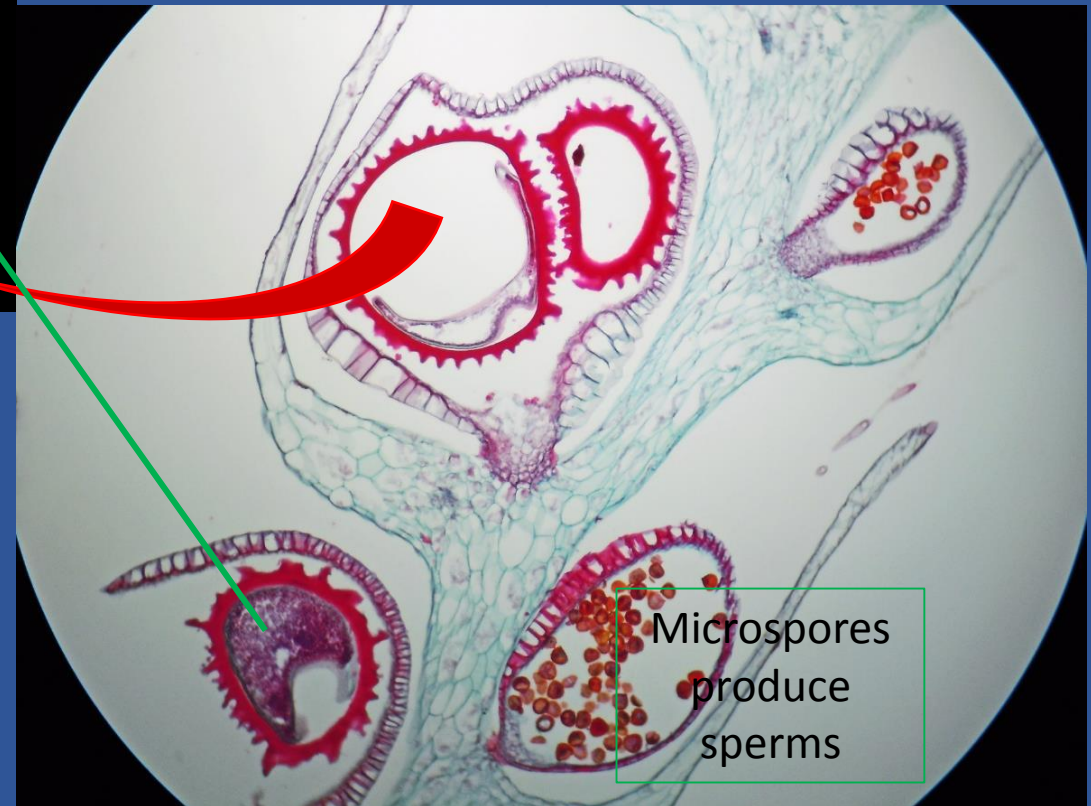
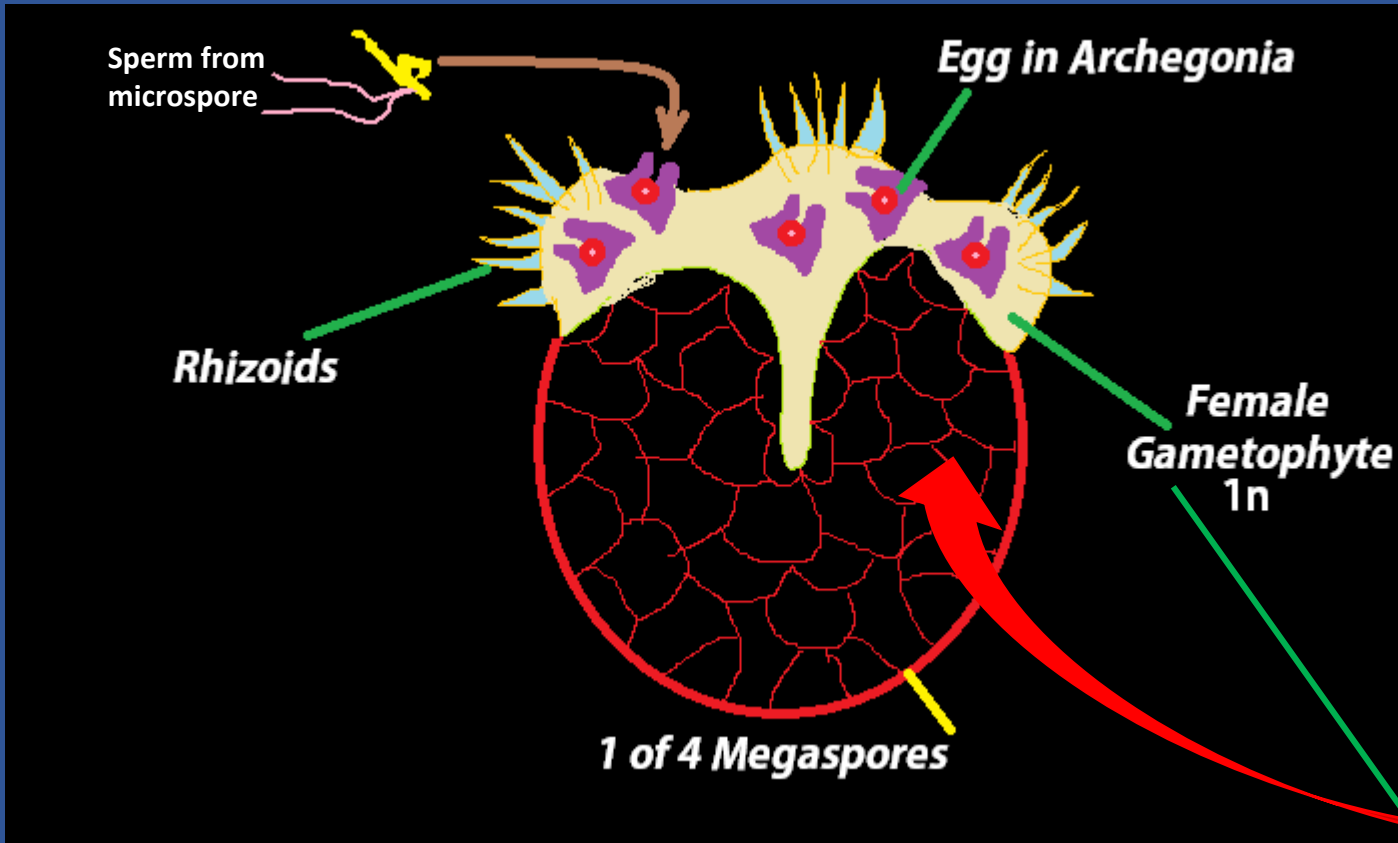
CS Rhizome of Isoetes



Sporangia (w/ spores) in strobilus of *Selaginella*:
Heterosporous – megaspores (female w/ archegonia) & microspores (male produce sperm)

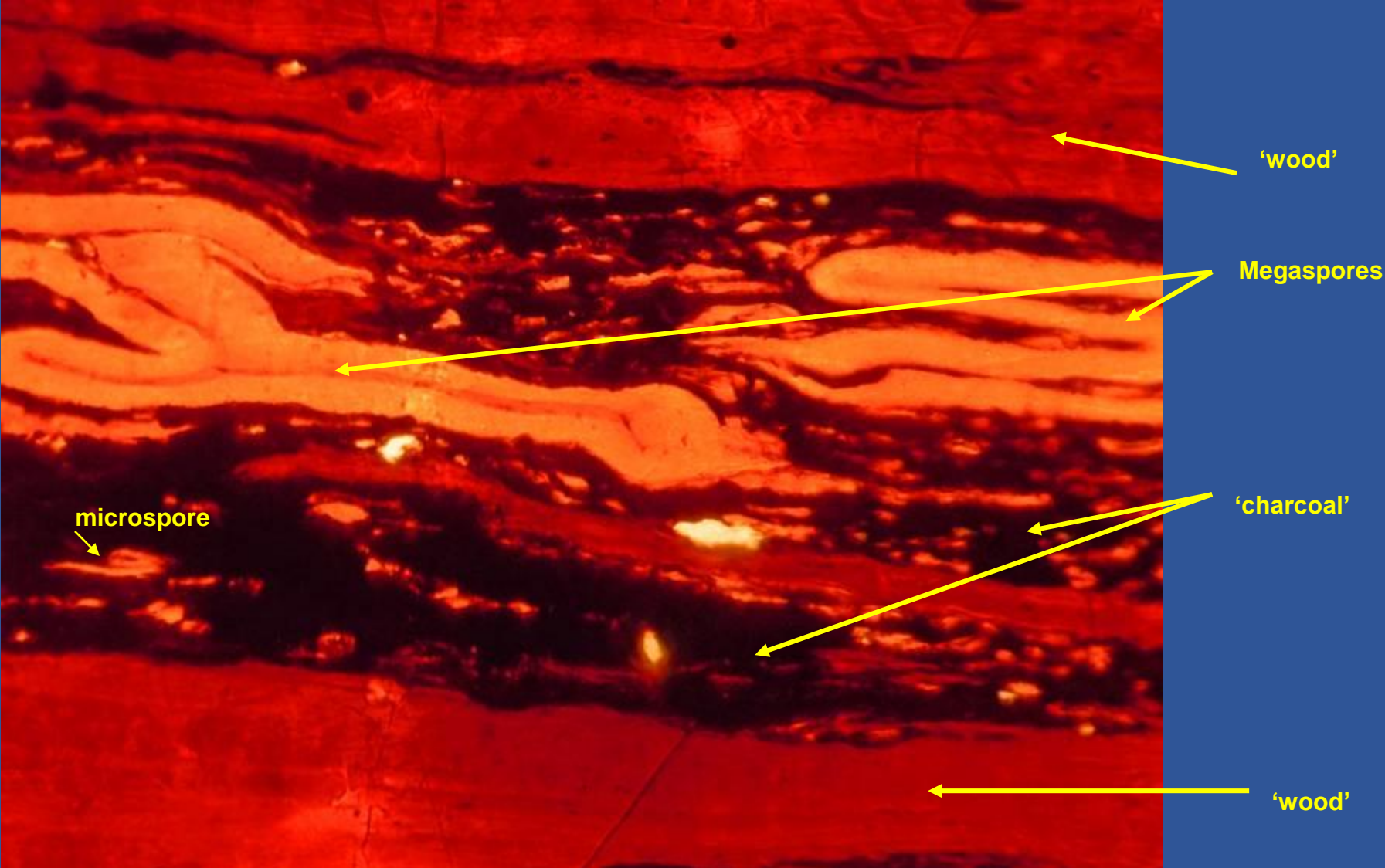


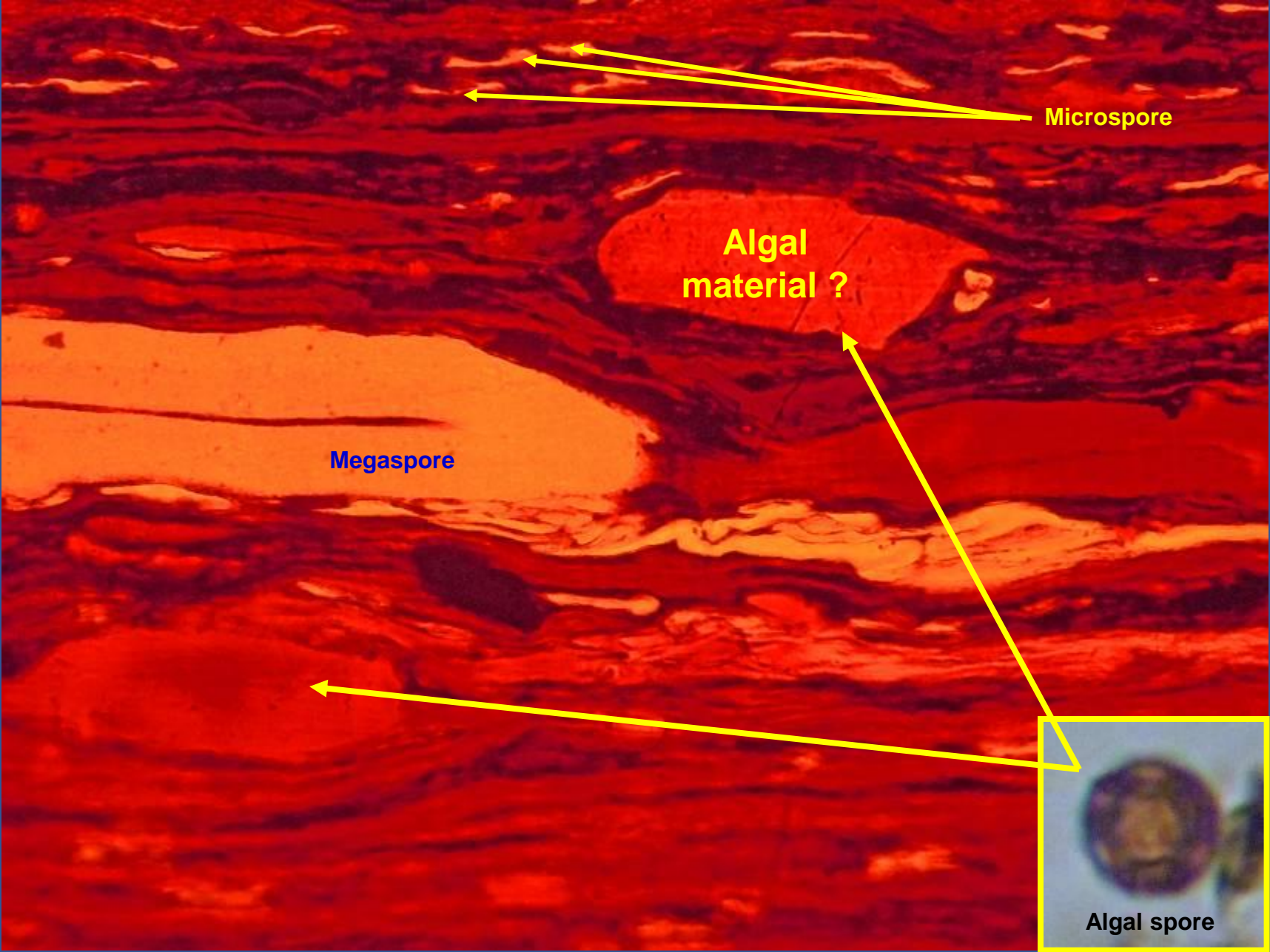
sporeling

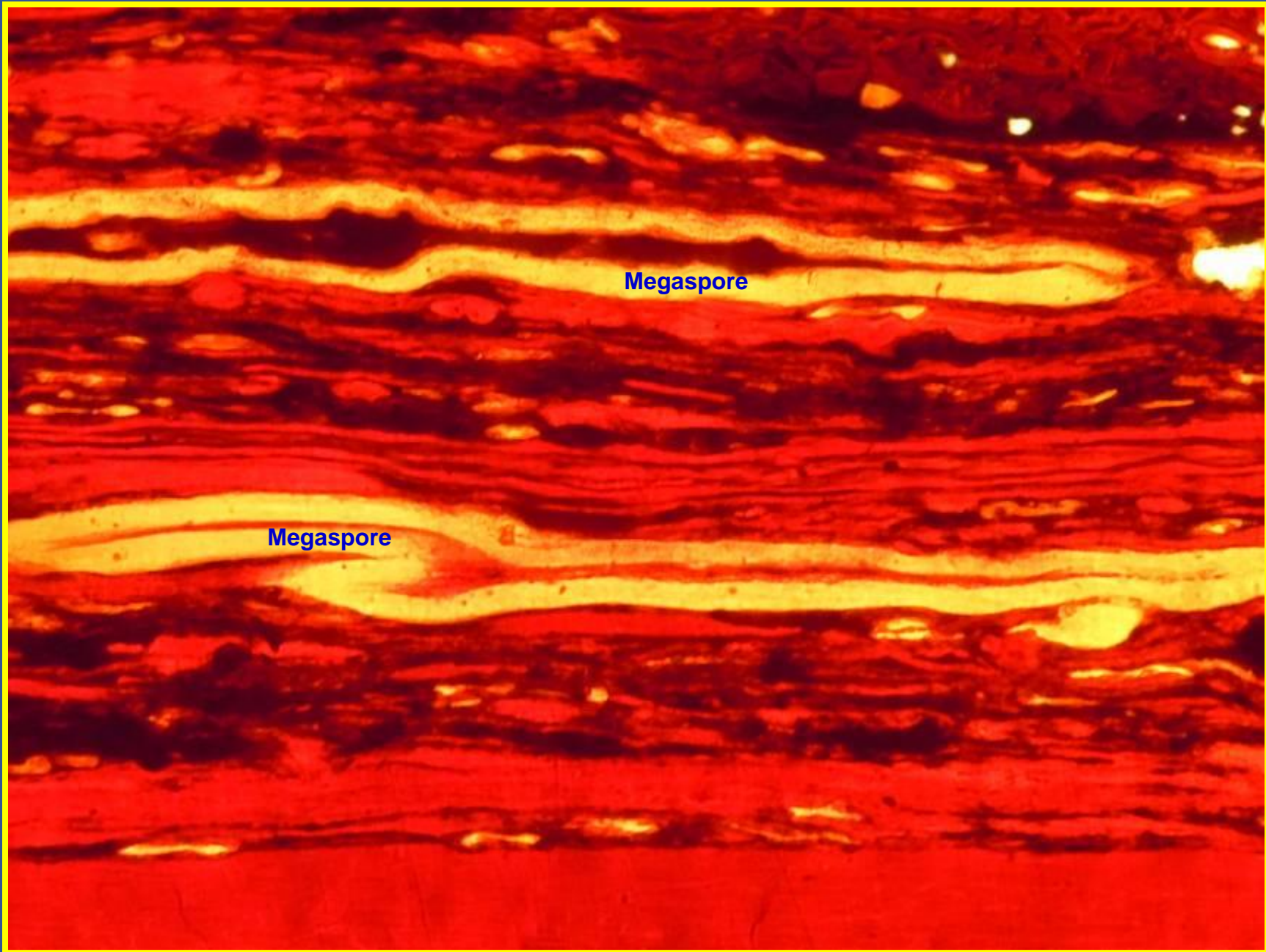


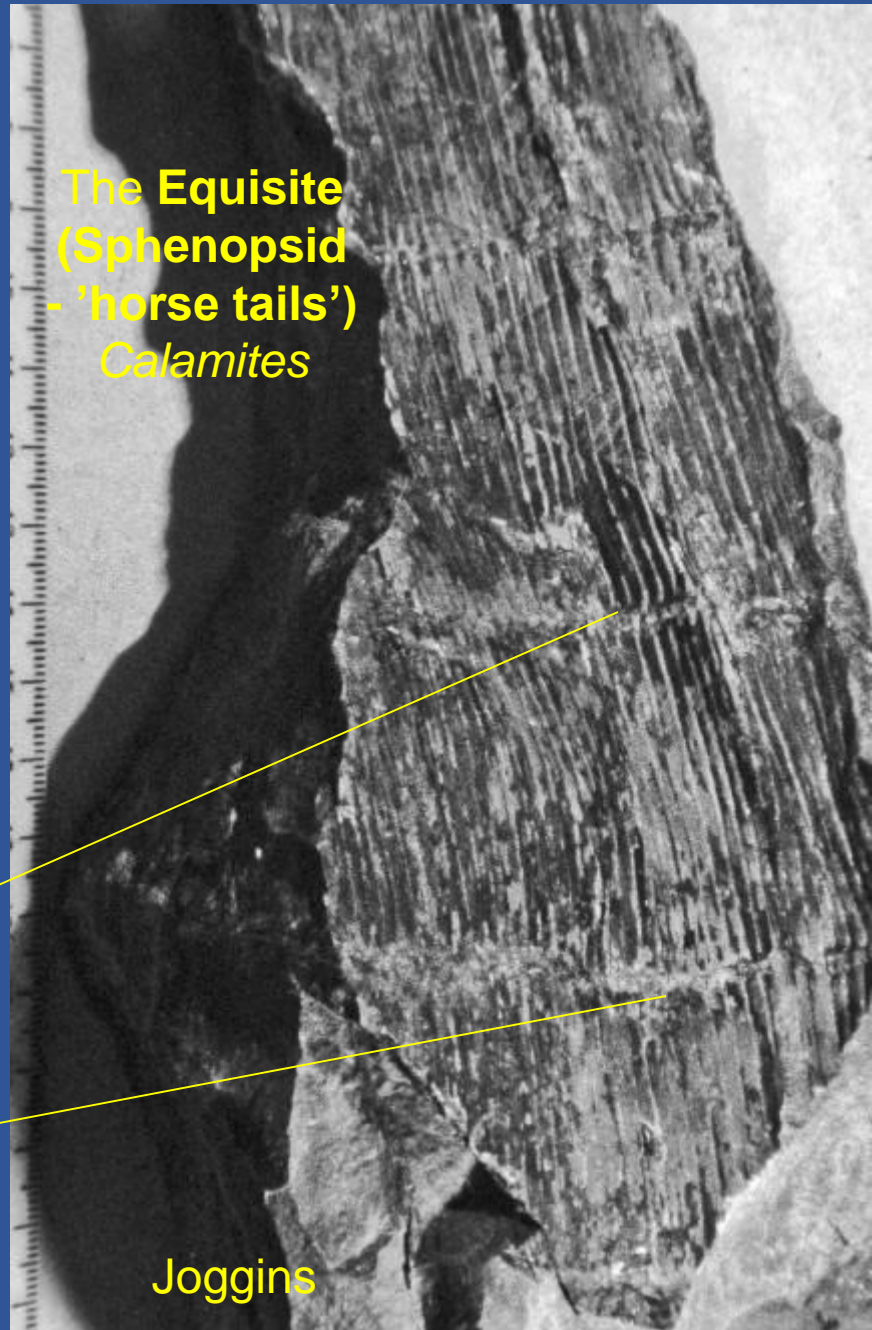
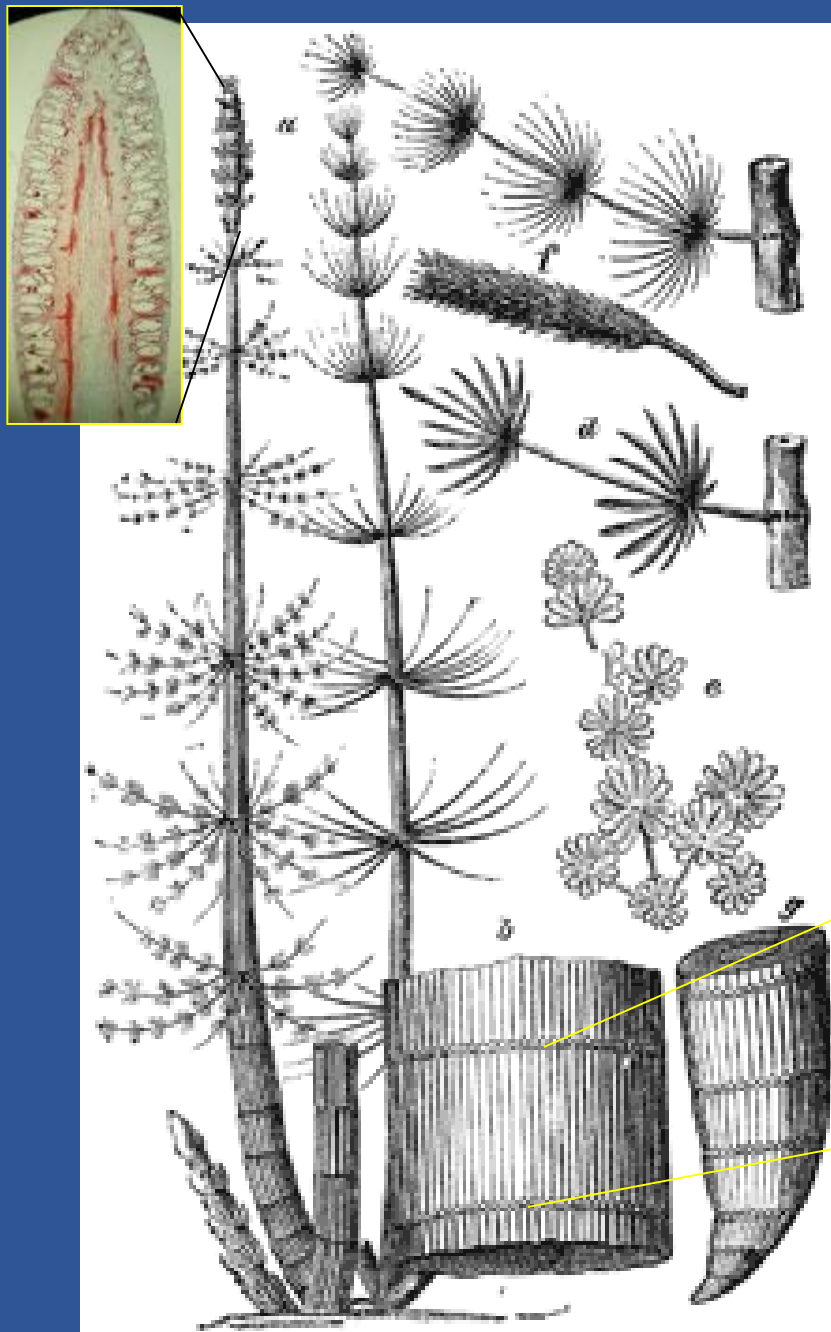
**Sporangia (w/ spores) in strobilus of *Selaginella*:
Heterosporous – megaspores (female w/ archegonia) &
microspores (male produce sperm)**

Mid Pennsylvanian to Early Permian (Dunkard?) Bituminous coal thin sections







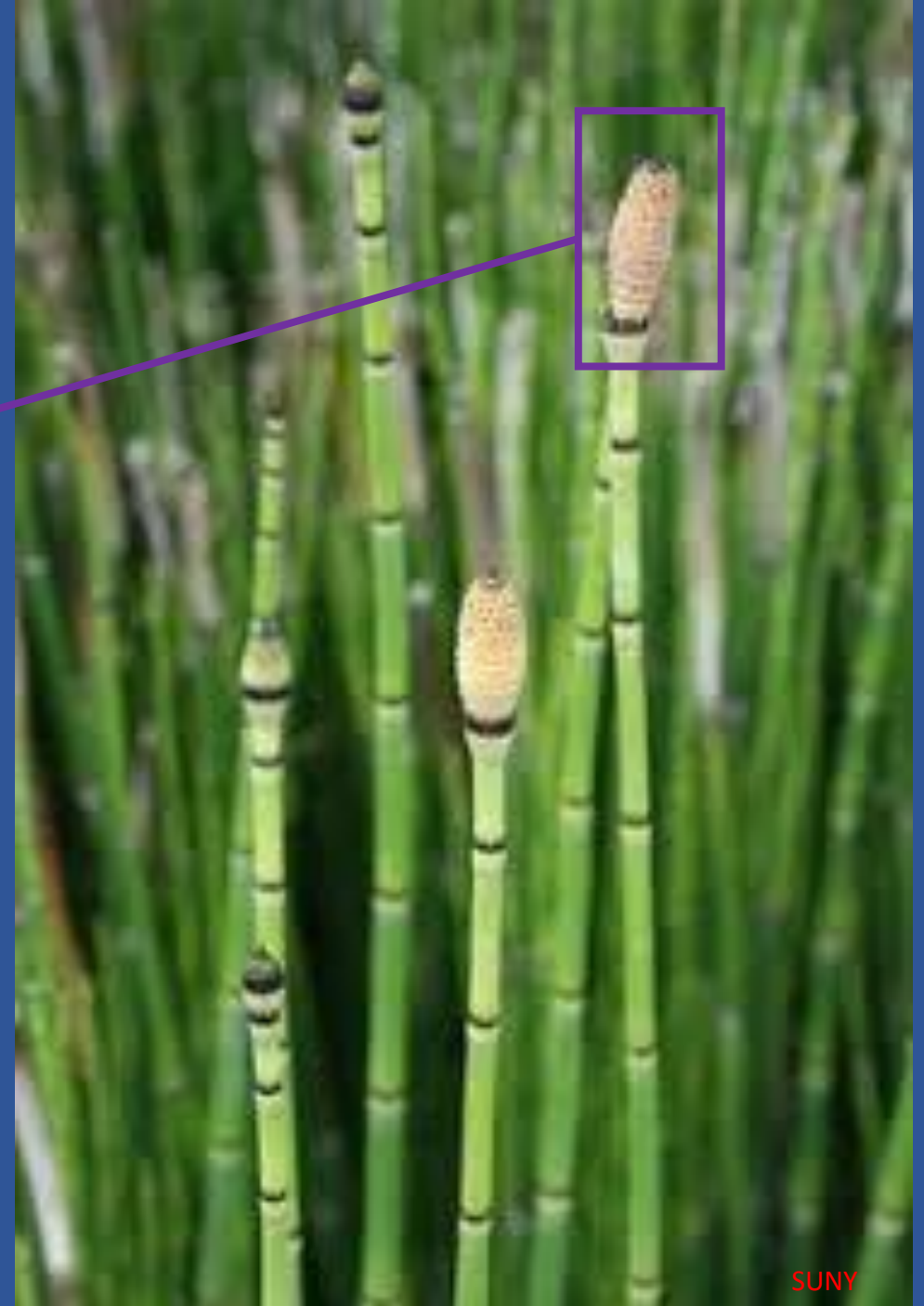
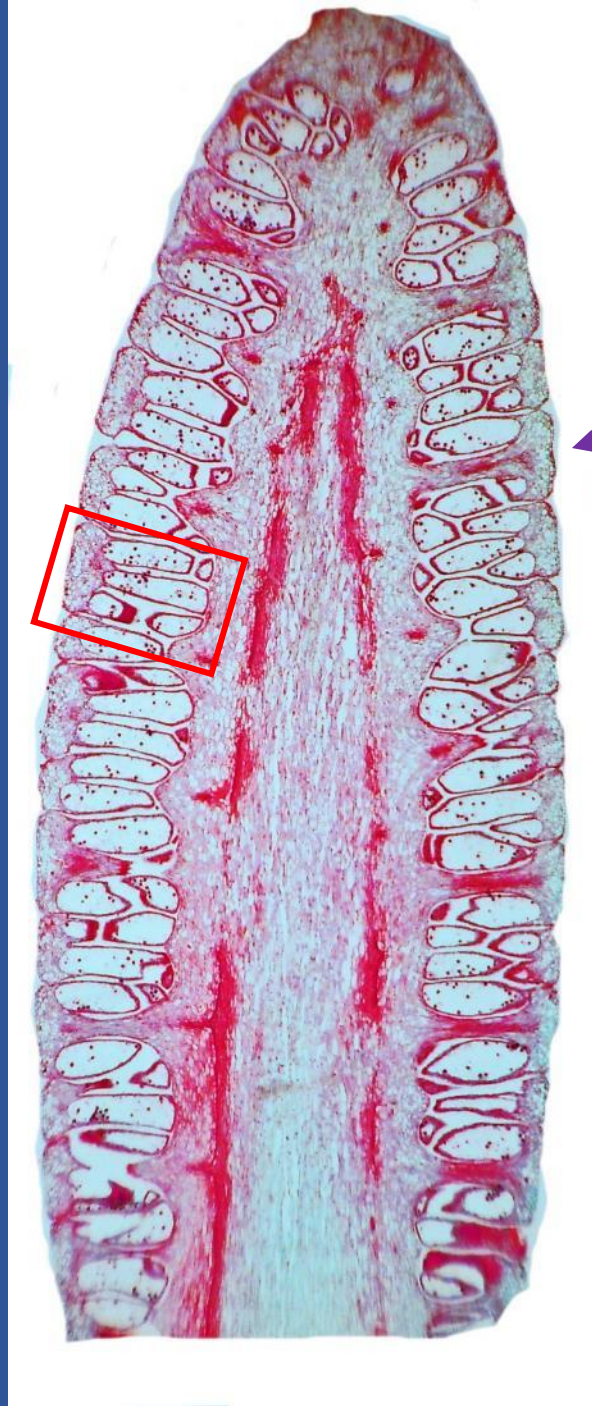


The Equisite
(Sphenopsid
- 'horse tails')
Calamites

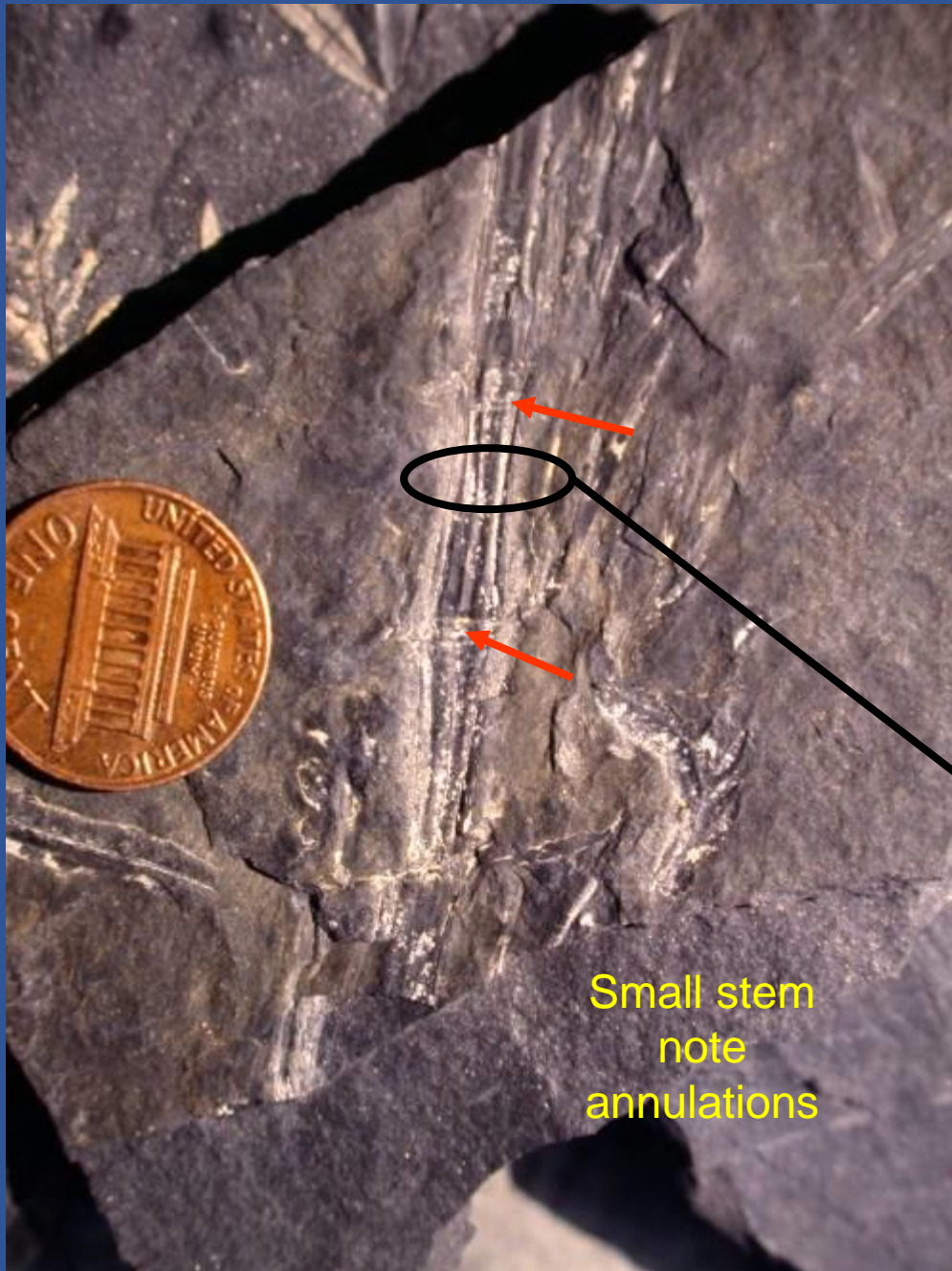
Joggins

Sphenopsids:
Equisetum the
'horsetails'

Sporophyte strobilus





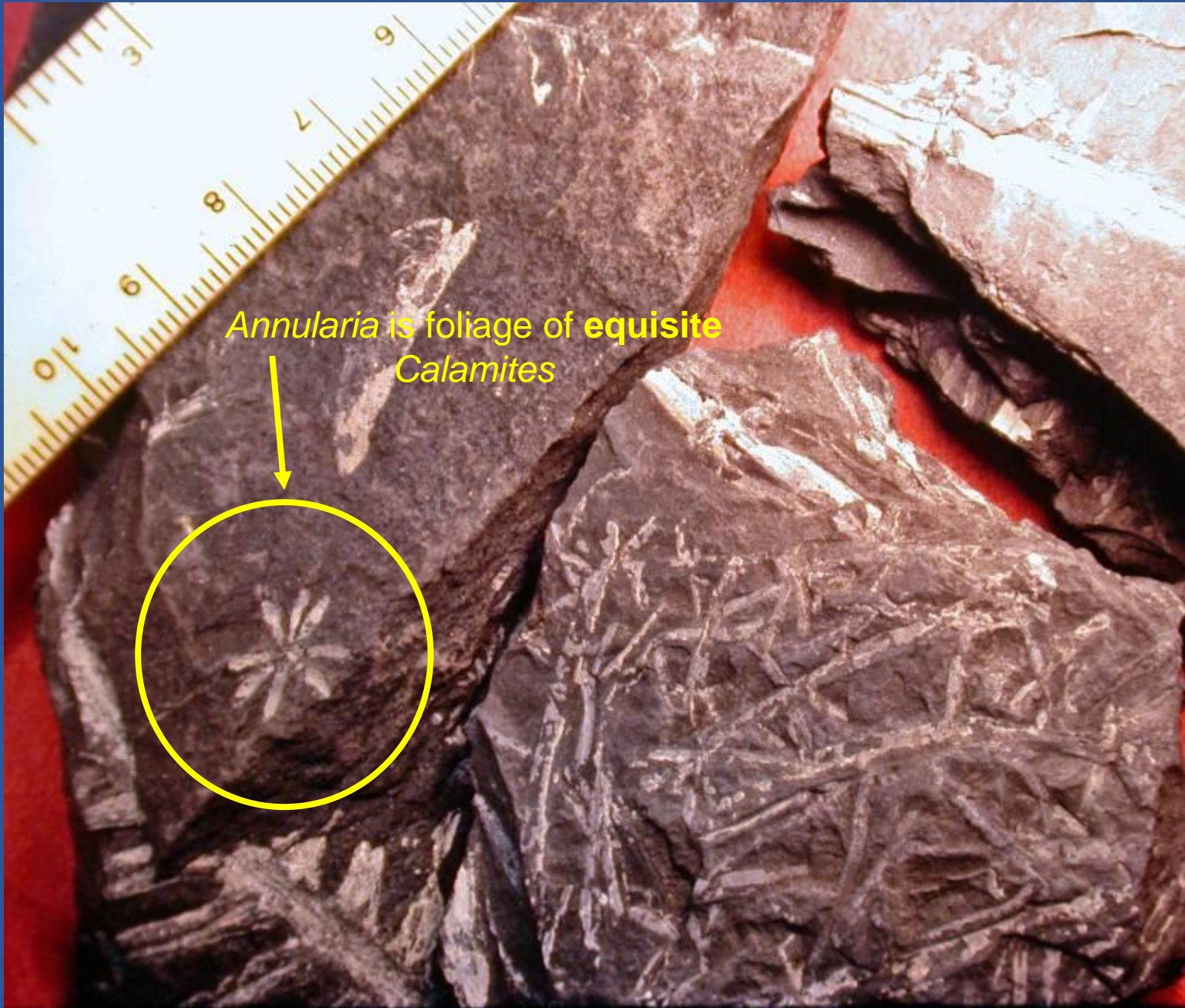


Equisite or Sphenopsid

Acetate peel of coal ball
from Illinois: cross
section of **equisite**
Calamites
Pennsylvanian Period

Small stem
node
annulations





Annularia is foliage of **equisite**
Calamites